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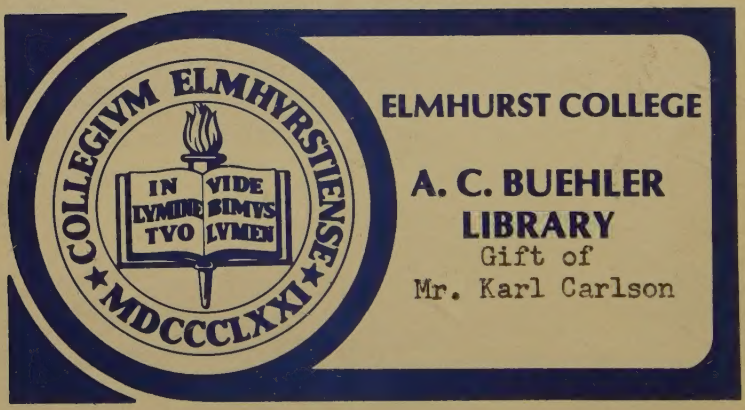
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LEONARDO DA VINCI'S NOTE-BOOKS

Frontispiece

Royal Library, Turin

LEONARDO DA VINCI

(DRAWN BY HIMSELF)

LEONARDO DA VINCI'S NOTE-BOOKS

Arranged and rendered into English with Introductions

BY

EDWARD McCURDY, M.A.

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AVANT PROPOS

There are many books of which it may be said that the world will survive their loss, and there are others so replete with inspiration that they should be in the hands of every student of human progress; for, when it is granted to us to become acquainted, even to a small extent, with the lives and efforts of those to whom the world is indebted, when we have placed before us the record of courageous struggle, of unwavering fortitude, we are often led to imitate and strive in accordance with the example set before us, and so bring to a successful termination what before promised to be defeat.

There is another advantage as well that comes from the study of these intimate records of a man's life: the broadening of the mental horizon as we strive to grasp the underlying motives that have produced such application, such devotion, to aims and ideals that, for the majority of us, have little or no drawing power. The very effort we make to understand the force that has commanded such self-sacrificing consecration to an end that has no attraction for us, brings us within the circle, and consequently, the influence of a new life, new vistas are open before us, and as we assimilate and grow we

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achieve one of the greatest things in life; we grow into further understanding of the infinite world of the human heart, we see things from a different angle; and the sympathies, once limited to a narrow sphere, have broadened out and embraced yet another truth. So in placing once more before the reading Public the Note Books of Leonardo da Vinci, we feel that we are performing a service for which that Public will feel grateful. The careful study of the work of one who stands out as one of the world's greatest intellects, whose prophetic vision was so keen that it has led to his being qualified as the forerunner of many aspects of modern scientific research, can only be of the greatest value to all those who are interested in tracing the advance of Human Achievement, and in particular, of studying those rare cases where the mind has leaped across the boundaries of the age in which it lived and worked.

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PREFACE

The manuscripts of Leonardo da Vinci afford the chief existing proof of that extraordinary versatility with which he has been credited from the time of his earliest biographers downwards. They comprise the records and results of his studies in the theory of art and in various branches of mathematical and natural science, together with fragments of literary composition of a philosophical or imaginative character, and in addition much personal and biographical matter. The manuscripts in their present form consist of about twenty note-books and bound volumes or collections of loose sheets of various sizes, containing altogether more than four thousand pages. While on many of these there are only drawings or scientific diagrams with at most a few words of comment or explanation, others are covered with minute writing, which with the rarest exceptions is of the character known as 'left-handed' from the fact of its direction across the page being from right to left, and which is therefore most easily read by the use of a mirror. The contents of these manuscripts, with the exception of such parts as are contained in the compilation known as Leonardo's *Treatise on Painting*, have up to the present time only been available to English readers in the edition

selected and edited by Dr. Richter. The period of more than twenty years which has now elapsed since the appearance of that important work has witnessed the publication *in extenso* of all the manuscripts of Leonardo at Paris and Milan with facsimile reproductions and transcripts, whilst a part of those at Windsor which treat of anatomy and the small volume 'on the flight of birds' have also appeared in a similar form; of the remainder of the Windsor manuscripts photographic facsimiles have been published. The quantity of material thus placed within reach of the student is the justification for a work of the scope of the present one. The above-mentioned editions have served as my text for the passages which I have taken from the Codice Atlantico, the Codice Trivulziano, the manuscripts at Paris and Windsor, and the volume 'on the flight of birds.' In the case of the manuscript in the British Museum and those at South Kensington I have worked from the originals. In the passages from these and from the Windsor facsimiles I have added a footnote where I have ventured to adopt a reading somewhat different from that found in the text as printed by Dr. Richter. For seven passages taken from the manuscript in the possession of the Earl of Leicester, I have used the text given in Dr. Richter's work, and also for some six lines that occur in the Windsor manuscripts which I have not been able to locate in the facsimiles; whilst for two passages from sheets in the Christ Church Library at

Oxford I am indebted to the texts in Mr. Sidney Colvin's *Oxford Drawings*.

My intention has been to present Leonardo as a writer, and to include in this work all passages from the note-books of philosophical, artistic, or literary interest. From the mass of the scientific writings I have drawn very sparingly, selecting only a few passages which either possess a more general interest or which may serve to illustrate his method of exposition. I have not included any of those passages which are simply the memoranda of scientific or mathematical processes, or those of which the importance is entirely biographical. These latter chiefly consist of notes of Leonardo's movements and household expenses, details as to his various commissions, and fragments of letters relating to the same. I have also thought fit to exclude the passages purporting to be letters addressed to the Devatdar of Syria, as their actual character is a matter of some uncertainty, and their literary value slight, as compared with the importance of the biographical issue which they raise, and any adequate discussion of that issue would travel far beyond the purpose of the present work. I have not included any of the allegories about animals which are found in MS. H of the Paris manuscripts, because they are merely extracts made by Leonardo from early bestiaries with at most verbal alterations; so also I have omitted the notes on armour and on methods of warfare in MS. B, as being derived in like manner from the

De re militari of Roberto Valturio. These facts may serve to suggest some of the difficulties of selection. The manuscripts were Leonardo's note-books, and as such they contain much unoriginal matter—some of it no doubt still unidentified—taken from various books which he read.

In the work of translation, trying at times to avoid the Charybdis of a too literal interpretation, I may have grounded my barque on the hidden reefs of Scylla which lie in the outer seas; but for the most part I have kept to the shallows.

The illustrations have been prepared from negatives specially taken for the purpose by Mr. Emery Walker. They have been chosen primarily with the intention of showing the degree of exactitude which characterised Leonardo's study of natural phenomena. I am indebted to Dr. W. S. Handley for the description of such of them as are of an anatomical character; and for repeated help in the deciphering of various difficult passages of the text I have to thank Mr. J. A. Herbert, of the Manuscripts Department of the British Museum.

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LIST OF PLATES

(The originals with the exception of the frontispiece are all to be found in the Royal Library at Windsor)

LEONARDO DA VINCI, BY HIMSELF, *Royal Library, Turin*, ... *Frontispiece*

1. STUDY OF A SKULL IN SECTION, TO SHOW THE BONY CAVITIES OF THE FACE, . . *Face p.* 50

This plate represents a skull sawn through in the median plane. The extreme front portion of the right half of the skull has been removed by a saw-cut at right angles to the median plane, so as to display the bony cavities or air spaces (frontal sinus, and maxillary antrum) which are present in the facial bones. The section also displays the nasal duct through which the tears pass down to the nasal cavity. On the left are seen typical teeth from the upper jaw: incisor, canine, bicuspid, and molar, with a full and accurate description appended. A transcript of the text is to be found in *I Manoscritti di L. da V. Dell' Anatomia, Fogli B*, pp. 249-50.

2. STUDIES OF THE DELTOID MUSCLE OF THE SHOULDER IN VARIOUS ASPECTS, . . *Face p.* 75

This plate is concerned almost entirely with the deltoid muscle of the shoulder, which is represented from various aspects and in various positions of the arm. The little drawing in

the centre below the middle of the page is not related to the one above it, and represents a dissection of the omo-hyoid muscle arising, as Leonardo believed, from the clavicle. The text contains the passages on the nature and number of the veins, which are to be found on pp. 79 and 80, also an account of the various movements of the neck, and explanations of the letters which occur on the smaller of the drawings. For transcript, see *I Manoscritti di L. da V. Dell' Anatomia, Fogli A*, pp. 67-69.

3. STUDIES IN THE ANATOMY OF THE NECK AND OF THE BONES OF THE FOOT, . . *Face p.* 78

This plate illustrates the anatomy of (*a*) the bones of the left foot, seen from above and from below; (*b*) the muscular and other structures of the neck, seen from various aspects. In one of the passages of the text Leonardo gives the number of the bones of the foot as twenty-seven. For transcript, see *I Manoscritti di L. da V. Dell' Anatomia, Fogli A*, pp. 75-6.

4. STUDIES OF A SKULL IN MEDIAN SECTION, *Face p.* 84

In the upper drawing half the vault of the skull has been removed in order to show the cranial cavity.

In the lower drawing the skull and the upper part of the spinal column are seen in a section through the mid-plane of the body. The spinal column appears to be unnaturally straight. The lines on the drawing are to show *inter alia* that the point about which the skull rotates is one third the vertical distance from the level of the chin to the level of the crown of the head. For transcript, see *I Manoscritti di L. da V. Dell' Anatomia, Fogli B*, p. 243.

5. LANDSCAPE WITH CLOUD EFFECT, . . *Face p.* 125

6. Page of MS. 'For the Shrine of Venus' (*Pel sito di Venere*), together with Architectural Studies and Sketch of Neptune with his Horses, . . . *Face p.* 131

The heads and legs of horses seen at the base of the standing figure show its connection with the composition of Neptune in his chariot drawn by sea-horses, which, according to Vasari, Leonardo drew for Antonio Segni. The head of the horse on the right recalls the larger spirited study for the same composition at Windsor (Grosvenor Gallery Portfolio No. 48) From a note on the last-named drawing '*abassi i chavalli*' (make the horses lower), it may be inferred that the plate represents the later of the two versions. Leonardo was apparently dissatisfied with an arrangement in which the position of the figure suggests a charioteer quite as much as it does a deity, and altered it to represent the god in an erect position. The figure has a considerable similarity to that of the David of Michelangelo, but is not improbably of earlier date.

7. Genista Tinctoria (*Dyers' Greenweed*) and Acorns and Leaves of the Stalked Oak (*Quercus Robur Pedunculata*), . . *Face p.* 163

8. Study of Drapery of Kneeling Figure, *Face p.* 186

9. Bramble (*Rubus Fruticosus*), . . . *Face p.* 212

10. Grove of Silver Birches, . . . *Face p.* 242

11. Study of Tree, ... *Face p.* 248

12. COLUMBINE (*Aquilegia Vulgaris*), . . . *Face p.* 262

13. RANUNCULUS REPENS (*Creeping Crowfoot*), ORNITHOGALUM UMBELLIFERUM (*Star of Bethlehem*), ANEMONE NEMOROSA (*Wood Anemone*), EUPHORBIA ESULA (*Leafy-Branched Spurge*), ... *Face p.* 274

LEONARDO DA VINCI'S NOTE-BOOKS

INTRODUCTION

THE unknown author of *Aetna* at the outset of his song disclaims all sympathy with the fictions of poets who represent the mountain as the forge of Vulcan, the kilns of the Cyclops, or the mound beneath which lies the giant Enceladus breathing smoke and flame. Fables all! And the bards who utter them not content with earth as their province think to tell of the wars of the Gods, and the shapes which Jove assumes!

His work shall treat of Aetna itself, not the legends about it. His purpose is to trace the mighty workings of nature as revealed in the mountain's hidden fires.

This he proceeded to do with scientific thoroughness; yet it would seem that the reservation pressed somewhat hardly upon the poetic instinct; so soon as ever his purpose was accomplished the muse led him back in apparent contentment to the scorned fables.

An analogy—at best a partial thing—may here serve to break the shore-ice of the sea of conjecture. The early biographers of Leonardo da Vinci cultivated the picturesque with an almost metrical licence. Their narratives, which together constitute what Pater has termed the *légende*, are as inadequate to reveal his work and personality, as the fables of Vulcan's forge and

the like are unsatisfying as an origin for Aetna's fire. Moreover, in the different aspects which Aetna has assumed to the imagination, seeming at first a caprice of the Gods and a thing of rhapsody, and subsequently—as the tenor of thought changed—a field for the scientific study of the forces of nature, there is presented a contrast no less sharply defined, and in its main features somewhat closely corresponding to that presented by the personality of Leonardo as shown in the earliest biographies and in the light of modern research. For the capricious volatile prodigy of youthful genius which the *légende* has bequeathed, the latter has substituted a figure less romantic, less alluringly inexplicable, but of even more varied and astonishing gifts. His greatness as an artist has suffered no change, but modern research has revealed the ordered continuity of effort which preceded achievement. It has made manifest how he studied the structure of the human frame, of the horse, of rocks, and trees, in order the better to paint and make statues, in that his work would then be upon the things he knew, and no sinew or leaf would be conventional, but taken directly from the treasury of nature; since the artist should be 'the son, not the grandson of nature.'

This habit of scientific investigation in inception subsidiary to the practice of his art so grew to dominate it as to gradually alienate him from its practice to the study of its laws, and then of those which govern all created nature. The fruits of these studies lay hidden in manuscripts, of which the contents have only become fully known within the last quarter of a century. So by a curious appositeness he is associated in each age with the

predominant current of its activity. His versatility in the arts caused him to seem an embodiment of the spirit of the Renaissance. Alike as painter, sculptor, architect, engineer, and musician, he aroused the wonder and admiration of his contemporaries. But to them, the studies which traversed the whole domain of nature, prefiguring in their scope what the spirit of the Renaissance should afterwards become, were so imperfectly comprehended as to seem mere trifles, 'ghiribizzi,' to be mentioned apologetically, if at all, as showing the wayward inconstancy of genius, and with regret on account of the time thus wasted which might have been spent on painting. Modern savants have resolved these trifles, and in so doing have estimated the value of Leonardo's discoveries and observations in the realms of exact science. They have acclaimed him as one of the greatest of savants: not in completed endeavour which of itself reached fruition, but in conjecture and prefigurement of what the progress of science has in course of centuries established. Such conjecture, moreover, was not grounded in fantasy, but was the harvest of a lifetime of study of natural phenomena, and of close analysis of their laws. Anatomist, mathematician, chemist, geologist, botanist, astronomer, geographer,—the application of each of these titles is fully justified by the contents of his manuscripts at Milan, Paris, Windsor, and London.

To estimate aright the value of his researches in the various domains of science would require an almost encyclopaedic width of knowledge. In respect to these Leonardo himself in his manuscripts must be accounted his own best biographer, in spite of what may appear the

enigmatic brevity of some of his statements and inferences. It is not possible to claim for him originality in discovery in all the points wherein his researches anticipated principles which were subsequently established. So incomplete is the record of the intellectual life of Milan under the Sforzas, which has survived the storms of invasion that subsequently broke upon the city, as to cause positive statement on this point to be wellnigh impossible; something, however, should be allowed for the results of his intercourse with those who were occupied in the same fields of research. We are told that at a later period he was the friend of Marc Antonio della Torre who held the Chair of Anatomy in the University of Pavia, and that they mutually assisted each other's studies. He was also the friend of Fra Luca Pacioli the mathematician, and drew the diagrams for his *De Divina Proportione*, and the two were companions for some time in the autumn and winter of 1499, after leaving Milan together at the time of the French invasion. Numerous references and notes which occur throughout the manuscripts show that he was indefatigable in seeking to acquire knowledge from every possible source, either by obtaining the loan of books or treatises, or by application to those interested in the same studies. From the astrologers then to be found at Ludovic's court—Ambrogio da Rosate and the others—he learnt nothing. He rated their wisdom on a par with that of the alchemists and the seekers after perpetual motion. His study of the heavens differed from theirs as much in method as in purpose. His instruments were scientific, and even at times suggestively

modern. The line in the Codice Atlantico 'construct glasses to see the moon large' (fa occhiali da vedere la luna grande) refers, however, only to the use of magnifying glasses; the invention of the telescope is to be assigned to the century following.

At the commencement of the sixteenth century, the Ptolemaic theory of the Universe was still held in universal acceptance. Leonardo at first accepted it, and in his earlier writings the earth is represented as fixed, with the sun and moon revolving round it. He ended at some stage further on in the path of modern discovery. On a page of mathematical notes at Windsor he has written in large letters, 'the sun does not move' (il sole no si muove).

He has been spoken of as the forerunner of Bacon, of James Watt, of Sir Isaac Newton, of William Harvey. He cannot be said to have anticipated the discoveries with which their names are associated. It may, however, be claimed that he anticipated the methods of investigation which, when pursued to their logical issue, could not but lead to these discoveries.

The great anatomist Vesalius, after having given up his Chair of Anatomy in 1561 in order to become the court physician at Madrid, spoke of himself as still looking forward to studying 'that true bible as we count it of the human body and of the nature of man.' Sir Michael Foster takes these words as the keynote of the life-work of Vesalius:—'the true bible to read is nature itself, things as they are, not the printed pages of Galen or another; science comes by observation not by authority.' In method Leonardo was the forerunner

of Vesalius, and consequently of William Harvey, whose great work was the outcome of Vesalius's teaching. No passage in his writings constitutes an anticipation of Harvey's discovery. He knew that the blood moved just as he also knew that the sun did not move, but the law of the circulation of the blood was as far beyond the stage at which his deductions had arrived as was the discovery of Copernicus. It was his work to establish, even before the birth of Vesalius, that 'science comes by observation not by authority.' Yet he was no mere empiric. He knew the authorities. He quotes in his manuscripts from Mundinus's *Anatomia*, and he must have known the work of Galen to which Mundinus served as an introduction. At a time when the Church 'taught the sacredness of the human corpse, and was ready to punish as a sacrilege the use of the anatomist's scalpel,' Leonardo practised dissection; and he suffered in consequence of his temerity, since it was subsequent to the malicious laying of information concerning these experiments that the withdrawal of the papal favour brought about his departure from Rome in 1515. Of such temerity the anatomical drawings are a rich harvest. The pall of authority was thrown aside; the primary need was for actual investigation, and of this they are a record. He would agree, he says, as to it being better for the student to watch a demonstration in anatomy than to see his drawings 'if only it were possible to observe all the details shown in these drawings in a single figure; in which, with all your ability, you will not see nor acquire a knowledge of more than some few veins, while, in order to obtain an exact and complete knowledge of

these, I have dissected more than ten human bodies, destroying all the various members and removing even the very smallest particles of the flesh which surrounded these veins, without causing any effusion of blood other than the imperceptible bleeding of the capillary veins.'

It was after his examination of these drawings that the great anatomist Dr. William Hunter wrote that he was fully of opinion that 'Leonardo was the best Anatomist at that time in the world.'

Coleridge called Shakespeare 'myriad-minded.' If the Baconian contention were established the result would afford a parallel to the myriad-mindedness of Leonardo. Morelli speaks of him as 'perhaps the most richly gifted by nature among all the sons of men.' Equally emphatic is the tribute of Francis I. recorded by Benvenuto Cellini: 'He did not believe that any other man had come into the world who had attained so great knowledge as Leonardo, and that not only as sculptor, painter, and architect, for beyond that he was a profound philosopher.'

In regard to this undefined, ungarnered knowledge the prevalent note of the early biographers is frankly the marvellous. To us his personality seems to outspan the confines of his age, to project itself by the inherent force of its vitality down into modern times and so to take its due place among the intuitive influences of modern thought. To them on the other hand his personality projecting beyond the limits of his own age seemed to stretch back into the age of legend, to gather something of its *insouciance* and its mystery. The figure —never sufficiently to be extolled for beauty of person —wandering through princes' courts improvising songs,

bearing a lute as a gift from one patron to another, and playing upon it in such skilled fashion that that alone out of all the arts of which he had knowledge would suffice as 'open sesame' to win him welcome, seems indeed rather to have its habitation in Provence at the close of the twelfth century than to be that of a contemporary and fellow-citizen of Macchiavelli and Savonarola. In lieu of any such period of toilsome apprenticeship as Vasari's biographies lead us customarily to expect, there seems almost a Pallas-like maturity at birth. The angel painted by him when an apprentice causes his master to abandon the use of the brush, in chagrin that a mere child had surpassed him; and so, in like manner, we are told that a monster which he painted on a shield filled his own father with dismay. Unsatisfied with this mastery of the arts he sought to discern the arcana of nature; and whither the quest had led him it was not for a mere biographer to say. But each will help you to conjecture, with hints more expressive than words, and less rebuttable. Leonardo's scornful references to the pretended wisdom of alchemists, astrologers, and necromancers lay hidden meanwhile in the manuscripts, not available to contravene such suppositions.

The personality as represented in the early biographies is substantially that which is expressed in the phrase of Michelet 'Léonard, ce frère italien de Faust.' It tells of him that he chose rather to know than to be, and that curiosity led him within the forbidden portals! It represents in fact the popular mediaeval conception of scientific study. Much of the modern aesthetic appreciation is in its essential conception a more temperate

re-statement of the same point of view. Errors—or at any rate some of them !—are corrected in the light of the results of critical research from Amoretti downwards: the outlook nevertheless remains that of Vasari and the Anonimo Fiorentino ! Ruskin's dictum, that 'he debased his finer instincts by caricature and remained to the end of his days the slave of an archaic smile,' is at one with the opinion of the folk of Wittenberg who lamented Faust's use of the unhallowed arts which had made him Helen's lover. The true analogy lies not with Faust but with Goethe, between whom and Leonardo there is perhaps as great a psychological resemblance as ever has existed between two men of supreme genius. In each the purely artistic and creative faculties became subordinate, mastered by the sanity of the philosophical faculties.

In each alike the restless workings of the human spirit desiring to *know*, ranged over the various mediums of artistic expression, tempered them to its uses, and finally passed on, looking beyond the art to the thought itself, unsatisfied with what—even in its perfection of utterance—was but a pale reflex of the phenomena it would observe. The two parts of Goethe's *Faust* drama symbolise the gradual change of purpose, and may perhaps serve to represent Leonardo's two spheres of activity. Verrocchio's bottega and all the influences of the art world of Florence in the Quattrocento were for him tutelage and training, as the mediaeval chap-book legends and the newly arisen literature of the Romantic School were for the poet of Weimar. The result in each case was limpid, serene, majestic, for the elements

which had gone to the making of it, had been fused molten in the flame-heat of genius. Yet the man behind the artist is still unsatisfied. He never shares the artist's accomplishment with such measure of absorption as characterised Raphael and Giovanni Bellini. He has something of the aloofness of Faust. There is that within him which art's appeal to the senses never kindled into life, never impelled to utter to one of its moments the supreme shibboleth of Hedonism, 'Stay, thou art so fair.' All the allurements of the mediaeval chap-book legend were revealed in the first part of the *Faust* drama, then, this invocation being as yet unuttered, the thinker essays the problem. No beaten footsteps as before in this new avenue of approach! No clear limpidity of ordered effort! Titanic energy struggles painfully amid the chaos of dimly-perceived primaeval forces. The result—even the very effort itself—according to much critical opinion, was an artistic mistake.

The same judgment was passed on Leonardo's work as philosopher and scientist by the earliest of his biographers. Yet in each case the thinker is nearer to the verities. *Faust* is regenerated by the service of man from out of the hell of mediaeval tradition. It was the cramping fetter of mediaeval tradition upon thought which Leonardo toiled to unloose. It was his aim to extend the limits of man's knowledge of himself, of his structure, of his environments, of all the forms of life around him, of the manner of the building up of the earth and sea, and of the firmament of the heavens. To this end he toiled at the patient exposition of natural things, steadfastly, and in proud confidence of purpose.

'I wish,' he says, 'to work miracles; I may have fewer possessions than other men who are more tranquil and those who wish to grow rich in a day.'

Inchoate and comparatively barren of result as was his investigation of natural phenomena, it nevertheless was actual investigation, and it attained results. We may instance the passages in the manuscript at Holkham Hall, in which the fact of fossil shells being found in the higher mountain ridges of Lombardy, is used by a process of deductive reasoning, to show how at one time the waters covered the earth. The hypothetical argument that the presence of these shells is to be attributed to the Flood, he meets by considering the rate of the cockle's progress. It is a creature possessed of no swifter power of motion than the snail has when out of water. It cannot swim, but makes a furrow in the sand by means of its sides, and travels in this furrow a space of three to four braccia daily, and by such a method of progression, it could not in forty days have travelled from the Adriatic to Monferrato in Lombardy, a distance of two hundred and fifty miles. Neither is it a case of dead shells having been carried there by the force of the waves, for the living are recognisable by the shells being in pairs. Many other passages in the manuscripts might be cited to show by what varied paths he anticipated the modern methods of scientific investigation. The words which Pater uses of the Renaissance of the fifteenth century, 'in many things great rather by what it designed or aspired to do than by what it actually achieved' —applicable to Leonardo in respect of his work as an artist,—are no whit the less applicable in reference to his

work in science. Painting and sculpture filled only two of the facets of a mind, which, as a crystal, took the light from whatever quarter light came. As, however, it was in these arts that he accomplished most, so such of his writings as treat of them are on the whole the most practical. In science, for the most part he heralded the work of others; in respect to his writings on art, we may apply to him the words which Dürer uses of himself in a similar connection, 'what he set down with the pen he did with the hand.' It is this very factor of experience working in the mind, which at times causes an abrupt antithesis in the transition from the general principle to discussion of the means whereby it should be realised. His work may perhaps be considered to lose somewhat of its literary value in consequence, but it acquires an almost unique interest among treatises on art by its combination of the two standpoints of theory and practice. Of this, one of the most striking instances occurs in a passage which is only to be found in the recension of the Treatise on Painting in the Vatican (Ludwig, cap. 180). Leonardo there sums up, tritely and profoundly, what should be the painter's purpose, 'a good painter has two chief objects to paint, man and the intention of his soul, the former is easy the latter hard'; after which follows the eminently reasonable, if perhaps unexpected explanation, 'because he has to represent it by the attitudes and movements of the limbs'; and the knowledge of these he proceeds to say should be acquired by observing the dumb, because their movements are more natural than those of any other class of persons. This very practical direction how to approach towards

the realisation of an apparently abstract aim is entirely characteristic of his intention. The supreme misfortune, he says, is when theory outstrips performance. This essential practicality of mind brought about the result that in the more abstract portions of this branch of his writings his zest for first principles is most apparent. The sun, the origin of light and shade, is recognised as the first artist, and we are told that 'the first picture consisted merely in a line which surrounded the shadow of a man cast by the sun upon a wall'; and the comparison of poetry and painting resolves itself into a consideration of the relative importance of the senses to which the two arts make their appeal.

It is perhaps in the passages which indicate the manner in which particular scenes and actions should be represented in art that Leonardo's powers as a writer find their most impressive utterance. His natural inclination impelled him to the contemplation of the vast and awe-inspiring in nature; but in these terse, vivid, analytic descriptions, the consideration of the ultimate purpose operates throughout to restrain and co-ordinate. The descriptive passage entitled 'the way to represent a battle,' in which the effect is built up entirely by fidelity of detail, forms indeed a veritable triumph of realism. There can be no possibility of difference of opinion as to how Leonardo regarded warfare. It was a grim necessity, and he was himself busied on occasions in devising its instruments; but he had no illusions as to its real nature, he characterises it elsewhere as a 'bestial frenzy' (bestiallissima pazzia). Here, however, he never suffers his pen to digress from the work of simple description.

To generalise would be alien to his purpose, which is to show how to portray a battle in progress. Consequently he shows what it is that is actually happening amid the clouds of dust and smoke and the rain of gunshot and falling arrows; and describes tersely, graphically, relentlessly the passions and agonies of the combatants as shown in their faces and their actions, the bitterness of the deaths of the vanquished, the fury and exhaustion of the victors and the mad terror of the horses, since these should find a place in the work of whosoever would represent war; 'and see to it,' he says in conclusion, 'that you make no level spot of ground that is not trampled over with blood.' The passage enables us in part to realise what he sets himself to represent in the picture of the Battle of Anghiari. It is, however, far more than a mere note for a picture. It possesses an interest and value apart either from this fact or from the mastery in the art of writing which it reveals. Its ultimate value is moral and didactic. He forbears to generalise but constrains the reader in his stead. His description is of the identical spirit which has animated the creations of Tolstoi and Verestchagin. Like these Leonardo seems to seek to make war impossible, by showing it stripped of all its pageantry and trappings, in its naked and hideous reality.

The passages which describe a tempest and a deluge and their representation in painting possess the same vigorous realism and fidelity of detail, and contain some of Leonardo's most eloquent and picturesque writing; and among the other notes connected with pictures we may instance that for the 'Last Supper,' descriptive of

the actions of the disciples, which, although of far slighter mould than any of the passages already referred to, yet possesses a restrained but very distinct dramatic power. These same qualities may be discerned perhaps even to more advantage in one of the very rare comments on public events which are to be found in his writings. After Ludovic Sforza's attempt to regain possession of Lombardy had ended with his defeat and capture at the battle of Novara in April 1500, Leonardo wrote among notes on various matters, 'The Duke has lost his State, his possessions, and his liberty, and he has seen none of his works finished.' (Il Duca perse lo Stato e la roba e la libertà, e nessuna sua opera si fini per lui.) Leonardo was a homeless wanderer in consequence of the events referred to, and one of the works of which the duke had not witnessed the completion was that of the statue on which Leonardo had been engaged intermittently during sixteen years, and the model of which had served as a target for the French soldiery; but this terse impassive comment is the only reference to these occurrences found in his writings. There is a certain poignant brevity and concentration in the sentence which suffices even to recall some of the most inevitable lines of Dante.

It is within the narrow limits of the short sentence and the apothegm that Leonardo's command of language is most luminous. In some of these the thought expressed is so wedded to the words as scarcely to suffer transference. 'Cosa bella mortale passa e non d'arte' is a type of the almost untranslatable; so also 'Sì come une giornata bene spesa dà lieto dormire così una vita bene usata dà lieto morire' must lose something of its

grace in any rendering. Certain of these sentences record the phenomena of nature so simply as to cause us almost to doubt whether they are intended to do more than this. 'All the flowers which see the sun mature their seed, and not the others, that is those which see only the reflection of the sun,' is perhaps written as an observation of nature without thought of a deeper meaning ; but it is hard to suppose that a similar restriction applies to the sentence 'tears come from the heart not from the brain,' although it is found in a manuscript which treats of anatomy.

It would seem that it was natural to him as a writer to use words as symbols and figuratively, thus employing things evident and revealed in metaphor. Of this habit of veiled utterance the section of his imaginative writings known as prophecies affords the most impressive and sustained series of instances. Some few of these are, as their name implies, a forecast of future conditions; many attack the vices and abuses of his own time. In the succinct, antithetical form of their composition Leonardo apparently created his own model.

There are questions more intimate than any of those which arise from the consideration of his achievement in these various arts and sciences ; questions which the mere number of these external interests tends to veil in comparative obscurity, causing us to regard Leonardo almost as a resultant of forces rather than as an individual, to see in him as it were an embodiment of the various intellectual tendencies of the Renaissance,—as though the achievements were the man! The figure crosses the stage of life in triumph, playing to perfection many parts !

But of these enough! Let us try to come nearer, to get past the cloak of his activities, and essay to 'pluck the heart out of this mystery.' As a means towards this end, let us consider his attitude with regard to certain of the problems of life.

His writings inculcate the highest morality, though rather as a reasoned process of the mind than as a revelation from an external authority. He preserves so complete a reticence on the subject of doctrinal belief as to leave very little base for inference as to his faith or lack of faith. The statement of Vasari that he did not conform to any religion, deeming it better perhaps to be a philosopher than a Christian, was omitted in the second edition of the *Lives*, and may therefore be looked upon as probably merely a crystallisation of some piece of Florentine gossip. It would be idle to attempt to surmise as to the reason of the withdrawal. To whatever cause it may have been due, its significance is no whit the less as outweighing a mass of suggestion and vain repetition on this subject by later writers. In temperament Leonardo has something akin to certain of the precursors or the Reformation. In any conflict between the dictates of reason and of authority, he would be found on the side of freedom of thought. 'Whoever,' he wrote, 'in discussion adduces authority uses not his intellect but rather memory.'

The cast of his mind was anti-clerical. His indignation at the abuses and corruption of the Church found expression in satire as direct and piercing as that of Erasmus. His scorn of the vices of the priesthood, of their encouragement of superstition, of the trade in

miracles and pardons, which is eloquently expressed in the section of his writings known as 'the prophecies,' may not unnaturally have earned for him the title of heretic from those whom he attacked. His quarrel lay, however, not with the foundations on which faith rested, but with what he conceived to be its degradation in practice by its votaries. His own path lay along the field of scientific inquiry; but where the results of this research seemed at variance with revealed truth, he would reserve the issue, disclaiming the suggestion of antagonism. Nature indeed cannot break her own laws. The processes of science are sure,—but there are regions where we cannot follow them. 'Our body is subject to heaven, and heaven is subject to the spirit.' So at the conclusion of a passage describing the natural origin of life, he adds, 'I speak not against the sacred books, for they are supreme truth.' The words seem a protest against the sterile discussion of these things. There is indeed a reticence in the expression of the formulas of faith, but the strands of its presence may be seen in the web of life.

The impelling necessity to use life fully is the ever recurrent burden of his moral sayings:

'Life well spent is long.'

'Thou, O God, dost sell unto us all good things at the price of labour.'

'As a well-spent day brings happy sleep, so life well used brings happy death.'

This vision of the end is steadfast. Death follows life even as sleep rounds off the day, and as we work well in the day, so sleep when it comes is happy and

untroubled. During the passing of the day there is so much to be done, such opportunity to construct and to observe, so much knowledge to be won about this world wherein the day is passed, that there is scarce time remaining in which to stand in fear and wonder at thought of what chimeras the coming shadow may hold within it. It is better to use to-day than to spend it in questioning of to-morrow. Duty in life is clear and we must follow it. When he speaks of what comes after, it is with that hesitance common to all, unless to speak of it be made habituate by custom, for to all, whatever be their belief, there yet remains something unknowable in the conditions of the change.

In one of the most beautiful passages of his writings, —a fragment on time, the destroyer—Leonardo describes Helen in her old age as looking into her mirror and seeing there the wrinkles which time had imprinted on her face, and then weeping, and wondering why she had been twice carried away. Beautiful as is the description, the hand which penned it is pre-eminently that of the scientist; we seem to see the anatomist at work with the scalpel, so minute is the observation therein revealed as to the effect of age and of the relentless approach of death upon the human frame.

The frequent recurrence in his writings and in his drawings and grotesques of the physical tokens of decay and death argues, however, no morbid predilection such as was that shown by the painters of the *danse macabre*. It forms a proportioned part of his study and 'patient exposition' of the origin and development of the whole structure of man. In the results as we may read them,

there is no incursion of the personal note. His attitude is always that of an observer, looking with curious eyes, noting all the phenomena of physical change, but yet all the while preserving a strange impassivity. He never in any of his works or in his manuscripts gives the suggestion of possessing any of that regret at the passing of time which rings through Giorgione's sun-steeped idyls. Indeed, from all such lament, he expressly dissociates himself. Time, he assevers, stays long enough for those who use it. The mere fact of the inevitability of death forbids regret. It therefore cannot be an evil. He speaks of it as taking away the memory of evil, and compares it with the sleep which follows after the day. The thought of this sleep brings silence: when on rare occasion the silence is broken, he stands with Shakespeare and Montaigne, revealing, as they do, when they address themselves to the same question, a quiet confidence, serene and proud.

The author of *Virginibus Puerisque* discoursing whimsically upon the incidence and attributes of the tender passion, professes his utter inability to comprehend how any member of his own sex, with at most two exceptions, can ever have been found worthy to be its object. 'It might be very well,' he says, 'if the Apollo Belvedere should suddenly glow all over into life, and step forward from the pedestal with that god-like air of his. But of the misbegotten changelings who call themselves men and prate intolerably over dinner-tables, I never saw one who seemed worthy to inspire love—no, nor read of any except Leonardo da Vinci and perhaps Goethe in his youth.'

The suggestion as to the Apollo Belvedere is in entire harmony with the associations of the names which follow. For if it had ever come to pass, as is conjectured in Heine's fantasy, that the gods of Greece, after their worship ceased, fallen on days of adversity, and constrained to baser uses, had walked the earth as men, surely no lives whereof record holds had come more naturally to Apollo's lot than would those of Goethe and Leonardo !

It would be vain to attempt to find better instances, yet these give only a capricious support at best to Stevenson's contention. They afford far more proof of his amazing temerity in attempting to view the kingdom of sentiment from the feminine standpoint. These two names he ranks together in isolation from the rest of their sex—and this in respect precisely of that condition wherein the records of their lives reveal the least resemblance. Goethe was as susceptible and almost as fickle as Jupiter himself. The story of his heart is a romance with many chapters, each enshrining a new name, and all ending abruptly at the stage at which the poet remembers—at times somewhat tardily—the paramount claims of his art.

But in the case of Leonardo there are no grounds for supposing that any one such chapter was ever begun. None of his biographers connect his name with that of any woman in the way of love, nor do his own writings afford any such indication. They show that he lived only for the things of the mind. He would seem to have renounced deliberately all thought of participation in the tenderness of human relationship. He looked upon it as alien to the artist's supreme purpose : he must

needs be solitary in order to live entirely for his art. His conception of the mental conditions requisite for the production of great art presupposes something of that isolation expressed in Pater's phrase: 'each mind keeping as a solitary prisoner its own dream of a world.'

The praise of solitude has ever been a fecund theme, although much of the fervour of its votaries has resulted in little more than a reverberation of the monkish jingle, 'O beata solitudo, O sola beatitudo.' In so far as praise of solitude is dispraise of the world and fellow-men and the expression of desire to shun them and their activities it is a sterile thing and worse. Solitude is unnatural and only the use of it can justify the condition. May be that even then the dream will never come to birth! Certain it is that if it does we must suffer the pangs alone!

Concentration of the mind comes by solitude; and in this, according to Leonardo, its value to the artist consists. (Se tu sarai solo tu sarai tutto tuo.)

'If you are alone you belong entirely to yourself. If you are accompanied even by one companion you belong only half to yourself, or even less in proportion to the thoughtlessness of his conduct. . . . If you must have companionship choose it from your studio; it may then help you to obtain the advantages which result from different methods of study.'

Such companionship of the studio implies some such measure of equality of attainment as it can never have been his own lot to meet with after leaving the circle of Verrocchio and the art world of Florence. His own

later companions of the studio were his pupils and servants, and the only one of these whom he admitted to any degree of personal intimacy was Francesco de' Melzi, who seems to have stood to him in the concluding years of his life almost in the position of a son to a father.

Behind all his strength lay springs of tenderness; in life confined within the strait limits whereby his spirit proposed that its work should be more surely done, in his art they are manifest, therein revealing the repression of his life. His pictures are now so few that it would be to his drawings that we should chiefly look for support of this statement, and of these primarily perhaps to the many studies for Madonna pictures, and the sketches of children made in connection with them; also, however, to the two versions of the composition of the Madonna and Child with S. Anne. The differences between that in Burlington House and that in the Louvre show the artist's gradual growth of purpose. One motive, however, is found in both, namely, that the Madonna is represented as so entirely absorbed in her Child that she is entirely unconscious of aught else. With the exception of the Madonna della Seggiola, and perhaps certain others of Raphael's Madonnas, there is no Madonna picture in Italian art in which the conception is more human or the ecstasy of motherhood is rendered with greater tenderness. So 'l'art console de la vie'; and the same may be said in Leonardo's case of nature perhaps even more truly than of art. If indeed any thought of consolation can be suffered in connection with a life so confident and full! For man's work is

his ultimate self. Such human hopes as begin and end in the individual are puny even in their highest fulfilment, and the processes of nature, whatever their final end, seem eternal in contrast with their transience. He interpreted man's highest aim to consist in seeking to know and to hand on the lamp of knowledge.

The task of the student who should attempt to discern Leonardo amid the mass of tradition was compared with that ascribed to himself by the author of *Aetna*. In one of the noblest and most eloquently sustained passages of that work, the poet characterises the investigation of the forces of nature, and of the various phenomena of earth, sea, and sky, as the highest of all the objects of intellectual effort, and one which constituted in itself its own highest reward. The lines serve as a description of Leonardo's purpose, and his writings reveal how far this purpose was accomplished.

Non oculis solum pecudum miranda tueri
More, nec effusos in humum graue pascere corpus,
Nosse fidem rerum dubiasque exquirere causas,
Ingenium sacrare caputque attollere caelo,
Scire quot et quae sint magno natalia mundo
Principia, occasus metuunt an saecula pergunt. . . .

Et quaecumque iacent tanto miracula mundo
Non disiecta pati, nec aceruo condita rerum,
Sed manifesta notis certa disponere sede
Singula, diuina est animi ac iucunda uoluptas.

A RECORD OF THE MANUSCRIPTS

In the opening lines of the volume of manuscript notes 'begun at Florence in the house of Piero di Braccio Martelli, on the 22nd day of March, 1508,' now in the British Museum (Arundel MSS. 263), Leonardo explains the method of its composition. The passage may serve to summarise the impression made by the whole mass of Leonardo's manuscripts. 'This,' he says, 'will be a collection without order, made up of many sheets which I have copied here, hoping afterwards to arrange them in order in their proper places according to the subjects of which they treat; and I believe that before I am at the end of this I shall have to repeat the same thing several times; and therefore, O reader, blame me not, because the subjects are many, and the memory cannot retain them and say "this I will not write because I have already written it"; and if I wished to avoid falling into this mistake it would be necessary, in order to prevent repetition, that on every occasion when I wished to transcribe a passage I should always read over all the preceding portion, and this especially because long periods of time elapse between one time of writing and another.' Certain pages in the volume of manuscript in the British Museum would indeed seem to be of a much earlier date than this introductory sentence, and the whole body of the manuscripts as may be shown by the

time-references contained in them, extend over a period of some forty years, from Leonardo's early manhood to his old age. He commenced them during the time of his first residence in Florence, and was still adding to them when at Amboise.

The contents of this 'collection without order' are so diversified as to render wellnigh impossible any attempt at formal classification. In addition to the numerous fragments of letters, the personal records, the notes relating to his work as an artist, and the fragments of imaginative composition which are to be found therein, it presents by far the most complete record of his mental activity, and this may be said without exaggeration to have extended into practically all the avenues of human knowledge. These manuscripts serve in a sense to show the mind in its workshop, busied in researching, in making conjecture, and in recording phenomena, tempering to its uses, in so far as human instrument may, the vast forces of nature.

He projected many treatises which should embody the results of these researches. Notes in the manuscripts themselves record the various stages of their composition. Some still exist in a more or less complete form. Of the fragments of others the order of arrangement is now only a matter of conjecture. In the manuscripts at Windsor, which treat mainly of anatomy, a note, dated April 2, 1489, speaks of writing the book 'about the human figure.' The manuscript given to the Ambrosian Library by Cardinal Federico Borromeo, now MS. C. of the Institut de France, which is a treatise on light and shade, contains a note that 'on the 23rd day of April

1490, I commenced this book and recommenced the horse'—the latter reference being to the equestrian statue of Francesco Sforza. In August 1499 a note in the Codice Atlantico states that he was then writing 'upon movement and weight.' These dates are, however, of relatively less importance, because each of these subjects occupied his thoughts during a long period of years. The two first formed a part of the artist's complete equipment as Leonardo conceived it: the third found practical issue in his undertakings in canalisation and engineering in Lombardy, Tuscany, Romagna, and elsewhere. In connection with the former of these two divisions of his activities may be cited the treatise on the nature of water in the possession of the Earl of Leicester, and the same subject is also treated of among others in MS. F. of the Institut, which, according to a note, was commenced at Milan on the 12th of September 1508.

The manuscripts as a whole are picturesquely described in the diary of a certain Antonio de Beatis, the secretary of the Cardinal of Aragon, who with his patron visited Leonardo at Amboise in October 1517. The many wanderings of the painter's life were then ended, and he was living with Francesco Melzi and his servant Battista de Villanis in the manor house of Cloux, the gift of Francis I. The diary relates that he showed his guests three pictures, the S. John, the Madonna with S. Anne, and the portrait of a Florentine lady, painted at the request of Guiliano de' Medici, which cannot now be identified. It further states that paralysis had attacked his right hand, and that therefore he could no longer paint with such sweetness as formerly, but still occupied

himself in making drawings and giving instruction to others. (May the inference be that he then drew with the left hand? If so he presumably used it in the manuscripts, which are written backwards.)

'This gentleman has,' he continues, 'written of anatomy with such wealth of detail, illustrating by his art both limbs and muscles, nerves, veins and ligaments of the inward parts, and of all that may be demonstrated in the bodies of men and of women, in a way that has never before been equalled by any one else. And this we have seen with our own eyes, and he has also told us that he has dissected more than thirty bodies of men and women of all different ages. He has also treated of the nature of water, of various machines, and of other matters which he has dealt with in an endless number of volumes, and all in the common tongue, which when they are made public will be profitable and very delectable.' This description of the manuscripts—the only one by an eyewitness during Leonardo's lifetime—leads naturally to the supposition that, if not all, at any rate by far the greater part of them were in Leonardo's possession at the time that he went to France, and were at Cloux at the time of his death.

The manuscripts then passed into the possession of Francesco Melzi, to whom Leonardo in his will, dated April 23, 1518, bequeathed 'in return for the services and favours done him in the past,' 'each and all of the books of which the said Testator is at present possessed, together with the other instruments and portraits which belong to his art and calling as a Painter.' Melzi returned to Milan shortly after Leonardo's death and took the

manuscripts with him, and four years later a certain Alberto Bendedeo, writing from Milan to Alfonso d'Este, said that he believed that the Melzi whom Leonardo made his heir was in possession of 'such of his notebooks as treated of anatomy and many other beautiful things.'

Vasari visited Milan in 1566, and he states that Melzi, whom he saw, and who was then 'a beautiful and gentle old man,' possessed a great part of Leonardo's papers of the anatomy of the human body and kept them with as much care as though they were relics. Some of the manuscripts had already at this time passed into other hands, for Vasari refers to some which treated of painting and methods of drawing and colouring as being then in the possession of a certain Milanese painter whose name he does not mention. The care which had been taken of those in Melzi's possession ceased at his death, which occurred in 1570. Some years later no restriction was placed by Melzi's heirs upon the action of a certain Lelio Gavardi di Asola, a tutor in the Melzi family, who took thirteen of the volumes of manuscripts with him to Florence for the purpose of disposing of them to the Grand Duke, Francesco. The duke's death, however, prevented the realisation of this project, and Gavardi subsequently took the volumes with him to Pisa. Giovanni Ambrogio Mazzenta, a Milanese who was then at the University of Pisa studying law, remonstrated with Gavardi upon his conduct, and with such success that on Mazzenta's return to Milan in 1587 he took the volumes with him for the purpose of restoring them to the Melzi family. When, however, he attempted to perform this duty Dr. Orazio Melzi was so astonished

at his solicitude in the matter that he made him a present of all the thirteen volumes, telling him further that there were many other drawings by Leonardo lying uncared for in the attics of his villa at Vaprio. In 1590 Giovanni Ambrogio Mazzenta joined the Barnabite Order and the volumes were then given by him to his brothers. They seem to have talked somewhat freely about the incident, and in consequence, according to Ambrogio Mazzenta's account, many people were filled with the desire to obtain similar treasures, and Orazio Melzi gave away freely drawings, clay models, anatomical studies, and other precious relics from Leonardo's studio. Among the others who thus came into possession of works by Leonardo was the sculptor Pompeo Leoni who was employed in the service of the King of Spain. He afterwards induced Orazio Melzi, by the promise of obtaining for him official honours and preferment, to appeal to Guido Mazzenta, in whose possession they then were, to restore the volumes of Leonardo's manuscripts so that he might be enabled to present them to Philip II. Melzi's entreaties were successful in obtaining the return of seven volumes, and three of the others subsequently passed into Pompeo Leoni's possession on the death of one of the Mazzenta. Of the remaining three, according to Mazzenta's account, one was given to the Cardinal Federico Borromeo, and passed into the Ambrosian Library, which he founded in 1603; another was given to the painter Ambrogio Figini, who afterwards bequeathed it to Ercole Bianchi; it was subsequently in the possession of Joseph Smith, English Consul at Venice, and with the sale of his effects in 1759 all record of it ends; the

third was given to Charles Emmanuel, Duke of Savoy, and nothing further is known as to its history. Professor Govi has conjectured that it was perhaps burnt in one of the fires which occurred in the Royal Library at Turin in 1667 or 1679.

Some of the volumes of the manuscripts which had passed into the possession of Pompeo Leoni were afterwards cut in pieces by him in order to form one large volume from the leaves, together with some of the drawings which he had obtained from Melzi's villa at Vaprio. This volume, known as the Codice Atlantico on account of its size, contains four hundred and two sheets and more than seventeen hundred drawings, and bears on its cover the inscription :—

DISEGNI DI MACHINE ET
DELLE ARTI SECRETI
ET ALTRE COSE
DI LEONARDO DA VINCI
RACOLTI DA
POMPEO LEO
NI

Apparently the collector's instinct proved stronger in Pompeo Leoni than his original intention. He was subsequently in Madrid where he was engaged in executing bronzes for the royal tombs in the Escurial, but there is no evidence to show that he ever parted with any of Leonardo's manuscripts to Philip II. The Codice Atlantico remained in his possession until his death in 1610, and then passed to his heir, Polidoro Calchi, by whom it was sold in 1625 to Count Galeazzo Arconati. Two of Leonardo's manuscripts in Pompeo Leoni's

possession were included among his effects sold after his death at Madrid, and were then bought by Don Juan de Espina. It would seem probable that others of the manuscripts in Pompeo Leoni's possession descended to his heir Calchi, and from him passed into the possession of Count Arconati, because the latter in 1636 presented twelve volumes of Leonardo's manuscripts to the Ambrosian Library at Milan. The volume which Mazzenta had given to Cardinal Federico Borromeo had already been placed there in 1603, and in 1674 yet another volume of Leonardo's manuscripts was added by the gift of Count Orazio Archinti.

Of the list of twelve manuscripts as described in Count Arconati's deed of gift to the Ambrosian Library, the second was afterwards lost, and the fifth was removed from the Library,—it being, as the description shows, identical with the manuscript of Leonardo's which in about the year 1750 was bought from a Gaetano Caccia of Novara by Carlo Trivulzio and is now in the possession of Prince Trivulzio at Milan.—The remaining ten manuscripts of the Arconati donation, together with the two from Cardinal Federico Borromeo and Count Archinti respectively, were in the Ambrosian Library until 1796. There was then also with them a manuscript of ten sheets which treated of the eye, the *provenance* of which is unknown, but which it is conjectured had been substituted for the manuscript now in the collection of Prince Trivulzio. These thirteen manuscripts were all removed to Paris in the year 1796 in pursuance of the decree of Bonaparte as General-in-Chief of the Army of Italy of 30 Floréal An IV. (May 19, 1796), providing

for the appointment of an agent who should select such pictures and other works of art as might be worthy of transmission to France. The Codice Atlantico was in the Bibliothèque Nationale at Paris in August 1796. The other twelve volumes of the manuscripts were deposited in the Institut de France. In 1815 the Austrian Ambassador, as representing Lombardy, made application for the return of all the Leonardo manuscripts. The request was complied with as regards the Codice Atlantico, which was then restored to the Ambrosian Library at Milan, but the twelve volumes in the library of the Institut de France were apparently overlooked, and there they have since remained.

On their arrival in France the manuscripts were described by J. B. Venturi, who then marked them with the lettering whereby they have subsequently been distinguished. He gave their total number as fourteen, because MS. B contained an appendix of eighteen pages which could be separated and considered as the fourteenth volume.

This manuscript is identical with No. 3 in the Arconati donation, which is described as having at the end a small 'volumetto' of eighteen pages containing various mathematical figures and drawings of birds. This 'volumetto' seems in fact to have been treated somewhat as Venturi suggests by Count Guglielmo Libri, who frequently had access to the manuscripts in the Institut de France in the early part of last century, and who apparently abstracted it at some time previous to 1848, at which date its loss was discovered. In 1868 it was sold by Libri to Count Giacomo Manzoni of Lugo, and in 1892 it was acquired

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from Count Manzoni's heirs by M. Sabachnikoff, by whom it was published in the following year as *Il Coaice sul Volo degli Uccelli* (edit. Piumati and Sabachnikoff, Paris, 1893).

Two other manuscripts by Leonardo of sixty-eight and twenty-six pages respectively, now in the Bibliothèque Nationale (Nos. 2038 and 2037), must have originally formed part of the manuscripts A and B of the Institute. They tally both in the dimensions of the pages and in the subjects of which they treat, and their total numbers added to those of Manuscripts A and B respectively do not amount to quite the full numbers of the leaves which these two manuscripts possessed in 1636, as described in the list of the Arconati donation. The two manuscripts in the Bibliothèque Nationale were formerly in the collection of the late Earl of Ashburnham, who purchased them in 1875 from Count Libri, from whom, as we have seen, Count Manzoni had purchased the little volume 'on the Flight of Birds.' The mutilation of Manuscripts A and B of the Institute and the removal of the 'volumetto' was first discovered in the year 1848. It is impossible to avoid the inference that each was the work of Count Libri. The two manuscripts of the Bibliothèque Nationale have been included in the edition of the manuscripts of the Institute published in facsimile, with a transcript and French translation by M. Ravaisson-Mollien, in six volumes (Paris, 1880–1891).

The Codice Atlantico has also now been published in facsimile, with a transcript, under the direction of the Accademia dei Lincei, at Rome (1894-1904); and the

manuscript in the possession of Prince Trivulzio, which was formerly as we have seen in the Ambrosian Library as one of the Arconati bequest, has been published in facsimile with a transcript by Signor Beltrami (Milan, 1892).

We may now consider the Arconati bequest from another standpoint. The count's munificence was commemorated in the following inscription, which was set in marble on the wall of the staircase of the Ambrosian Library :

Leonardi . Vincii
manu . et . ingenio . celeberrimi
lucubrationum . volumina . XII
habes . o . civis
Galeaz . Arconatus
inter . optimates . tuos
bonarum . artium . cultor . optimus
repudiatis . regio . animo
quos . angliae . rex . pro . uno . tantum . offerebat
aureis . ter . mille . hispanicis
ne . tibi . tanti . viri . deesset . ornamentum
bibliothecae . ambrosianae . consecravit
ne . tanti . largitoris . deesset . memoria
quem . sanguis . quem . mores
Magno . Federico . fundatori
adstringunt
bibliothecae . conservatores
posuere
anno MDCXXXVII

'The glorious (boasting) inscription'—so described in the *Memoirs of John Evelyn*—has naturally attracted the attention of English travellers. Evelyn records his failure to obtain a sight of the manuscripts when he visited Milan in 1646, owing to the keeper of them

being away and having taken the keys, but states that he had been informed by the Lord Marshal, the Earl of Arundel, that all of them were small except one book, a huge folio containing four hundred leaves 'full of scratches of Indians,' and 'whereas,' he says, 'the inscription pretends that our King Charles had offered £1000 for them, my lord himself told me that it was he who treated with Galeazzo for himselfe in the name and by the permission of the king, and that the Duke of Feria, who was then Governor, should make the bargain: but my lord having seen them since did not think them of so much worth.' The inscription, however, does not mention the name of the king. Addison, in his 'Remarks on Several Parts of Italy,' in describing his visit to Milan in 1701, mentions the Ambrosian Library as containing 'a manuscript of Leonardus Vincius, wich King James I. could not procure, tho' he profer'd for it three thousand spanish pistoles'; and the monarch in question is also stated to have been James I. in the fuller record of the Arconati donation. The Duke of Feria was Governor of Milan from 1610 to 1633, during a part of the reign of both monarchs.

Apparently, however, the manuscripts only passed into the possession of Count Arconati in 1625, the year of the death of James I., and this renders it more probable that the monarch referred to was Charles I. But the question of under which king has relatively little import, and with regard to the inscription, it may perhaps be well to recall the dictum of Dr. Johnson, 'in lapidary inscriptions a man is not upon oath.' The only inference that can fairly be drawn from the present

instance is that the manuscripts by Leonardo now in the Royal Collection at Windsor did not form part of the Arconati Collection. This is also confirmed by the testimony of Lord Arundel, as recounted by Evelyn. That some of the Leonardo manuscripts at Windsor were once in the possession of Lord Arundel is established by the fact of the existence of an engraving of one of the drawings by Hollar, whom Lord Arundel brought from Prague and established in London, inscribed 'Leonardus da Vinci sic olim delineavit. W. Hollar fecit ex collectione Arundeliana.' That some of these Windsor manuscripts were also formerly in the Collection of Pompeo Leoni is clearly shown by the fact that one of the volumes is inscribed 'Disegni di Leonardo da Vinci Restaurati da Pompeo Leoni.'

Now two of the manuscripts in Pompeo Leoni's collection were, as has been already stated, purchased in Madrid after his death by Don Juan de Espina; and Mr. Alfred Marks,—from whose important contributions to this branch of the subject in the *Athenaeum* of February 23 and July 6, 1878, many of the foregoing facts are derived,—has shown that for one at any rate of these volumes, the Earl of Arundel was in treaty with Don Juan de Espina. The evidence of this is to be found in a note by Endymion Porter, of the date 1629, printed by Mr. Sainsbury in his *Original Unpublished Papers illustrative of the Life of Rubens*:—'of such things as my Lord Embassador S^r^ Francis Cottington is to send out of Spain for my Lord of Arondell; and not to forget the booke of drawings of Leonardo de Vinze w^ch^ is in Don Juan de Espinas hands' (p. 294). Don

Juan seems for a time to have proved obdurate, for Lord Arundel wrote on January 19th, 1636, to Lord Aston, who was then ambassador to Spain, 'I beseech y^{u} be mindfull of D. Jhon. de Spinas booke, if his foolish humour change' (p. 299). There the record breaks off. But as Mr. Marks truly observes, there can be little doubt that eventually a change did take place in Don Juan's 'foolish humour.' At whatever date this happened, the volume passed into Lord Arundel's possession. The earl may either have been negotiating for himself or for the king. If the former was the case, the book may presumably have passed into the Royal Collection at any time after 1646, when on the death of Lord Arundel, his collections were partially dispersed. If not acquired previously, the volume may have been bought in Holland by an agent of Charles II.

The earliest record of any of Leonardo's manuscripts or drawings as being in the royal possession occurs in an inventory found by Dr. Richter in the Manuscript Department of the British Museum, which states that some drawings of Leonardo da Vinci, marked with a cross, were delivered for her Majesty's use in the year 1728.

Dr. Richter also cites a note in an inventory at Windsor Castle written at the beginning of last century, in which a drawing of Leonardo's is referred to as not having been in the volume compiled by Pompeo Leoni, but in one of the volumes in the Buonfiluolo Collection bought at Venice. Nothing, apparently, is known about the collection here referred to, but the note is important as tending to prove that the manuscripts by Leonardo

now at Windsor, were not all acquired at the same time, and did not all form part of Pompeo Leoni's collection.

The volume of manuscript now in the British Museum (Arundel MSS., 263) was certainly once in the possession of Lord Arundel. Nothing is known of its history previous to this, and whether or no it belonged to Pompeo Leoni, or was acquired by purchase from Don Juan de Espina, it would be idle to attempt to conjecture. Lord Arundel had numerous agents in various parts of Europe, who were employed in collecting antiquities and works of art. It may, however, be noted that the greater part of his collection of manuscripts was acquired by the earl himself at Nuremberg in 1636, and had formerly belonged to Wilibald Pirkheimer the humanist, the friend of Erasmus and Dürer. If any opportunity presented itself to him, Pirkheimer would certainly have possessed himself of any manuscript of Leonardo's; but to suppose him to have done so would be to assume that some of the manuscripts passed into other hands during Leonardo's life-time, and this, though by no means impossible, is at any rate improbable.

The only other manuscripts by Leonardo now known to exist, with the exceptions of a few separate sheets of sketches and diagrams with explanatory text, are three small note-books in the Forster Library at South Kensington, and a volume of seventy-two pages in the possession of the Earl of Leicester at Holkham Hall. The former were acquired in Vienna for a small sum by the first Earl of Lytton and by him presented to Mr. Forster; the latter, according to a note on the title-page,

once belonged to the painter Giuseppe Ghezzi, who was living in Rome at the beginning of the eighteenth century, it having presumably been acquired by the first Earl of Leicester, who spent some years in Rome previous to 1775, and there acquired many art treasures. Its previous history is unknown. This volume—a treatise on the nature of water—is in all probability that referred to by Rafaelle du Fresne in the sketch of Leonardo's life which appears in his edition of the *Trattato della Pittura*, published in Paris in 1651, where it is stated that 'the undertaking of the canal of the Martesana was the occasion of his writing a book on the nature, weight, and motion of water, full of a great number of drawings of various wheels and engines for mills to regulate the flow of water and raise it to a height.'

Of such of the manuscripts at Windsor as treat of anatomy, two volumes with facsimiles, transcripts, and translations have been issued by Messrs. Piumati and Sabachnikoff (Paris, 1898), (Turin, 1901). The rest of the manuscripts at Windsor and the other manuscripts in England have not as yet been published, though facsimiles of those at Windsor and of portions of those in London have been issued in a series of volumes by Rouveyre.

As Leonardo's fame as a writer has chiefly rested upon the *Treatise on Painting*, it may not be out of place here to attempt to state the relation which this work bears to the original manuscripts.

The *Treatise* was first published by Rafaelle du Fresne, in Paris, in 1651, a French translation by Roland Freard sieur de Chambrai being also issued in the same year.

Du Fresne derived his text from two old copies of MS. 834 in the Barberini Library, which manuscript has now presumably been transferred to the Vatican, at the same time as the other contents of that Library. One of these copies had been made by the Cavaliere Cassiano del Pozzo, who had given it in 1640 to M. Chanteloup, by whom it was presented to du Fresne for the preparation of his edition; the other was lent him for the same object by M. Thevenot.

Another edition of the *Treatise* was issued in 1817 by Guglielmo Manzi, who took as his text a manuscript in the Vatican Library (Cod. Vat. (Urbinas) 1270), which had formerly belonged to the Library of the Dukes of Urbino. This manuscript is by far the more complete of the two, five out of the eight books which it contains being wanting in the version followed by du Fresne. There are, however, many omissions in Manzi's edition, and the only adequate critical edition of the Vatican manuscript is that published by H. Ludwig (*Leonardo da Vinci: Das Buch von der Malerei* (Bd. xv-xviii of *Quellenschriften für Kunstgeschichte*, etc., Edit. R. Eitelberger v. Edelberg), Vienna, 1882, Stuttgart 1885). This contains the complete text, together with a German translation and commentary, and also an analysis of the differences which exist between the manuscripts in the Vatican and Leonardo's own manuscripts.

The Vatican manuscript probably dates from the beginning of the sixteenth century. It has been ascribed to some immediate pupil of Leonardo's, for choice either Francesco Melzi or Salai, but there is no evidence which can be held to establish this view. Its close connection

with Leonardo is however indisputable. Whether this be the original form or no, the compilation was undoubtedly made previous to the dispersal of the manuscripts. About a quarter of the whole number of paragraphs (two hundred and twenty-five out of nine hundred and forty-four) are identical with passages in the extant manuscripts. Many others, which are not now to be found in any form in the manuscripts, yet carry their lineage incontestably, and would afford a sufficient proof, were this lacking in the chequered history of the various volumes, that some of the manuscripts have now perished; that, as with Leonardo as painter so also as writer, time has spared only the fragments of his work. The compiler of the *Treatise on Painting* had access to manuscripts, and probably also to sources of information as to the artist's intentions, of which we have no record. He presumably followed what he conceived to be the scheme of the artist's work. Nevertheless, Leonardo cannot be adjudged directly or even indirectly responsible for the arrangement and divisions of this treatise, and it is somewhat difficult to credit him with the whole of the contents. Certain of the passages read rather as repetitions by a pupil of a theme expounded by the master.

Did Leonardo himself ever give his work definite shape? Did he write a treatise on painting or only parts of one? In Fra Luca Pacioli's dedication to Ludovic Sforza of the *De Divina Proportione*, dated February 9, 1498, he speaks of Leonardo as having finished 'il Libro de Pictura et movimenti humani,' and Dr. Ludwig, who apparently accepts this statement, puts forward the

supposition that the treatise was in the possession of Ludovic and probably became lost at the time of the French invasion of Milan.

On this same occasion, according to both Vasari and Lomazzo, there also perished a treatise by Leonardo on the anatomy of the horse, which he had written in the course of his studies for the Sforza statue.

Vasari, as we have seen, mentions some writings by Leonardo 'which treat of painting and of the methods of drawing and colouring' as being then in the possession of a Milanese painter, who had recently been to see him in Florence to discuss their publication, and had taken them to Rome in order to carry his intention into effect, though with what result Vasari could not say. These writings are stated to be 'in characters written with the left hand, backwards,' and therefore they cannot possibly be identical either with the Barberini or the Vatican manuscript. Seeing that Vasari wrote during Melzi's lifetime, it is reasonable to infer that this manuscript had at an early date become separated from the others and therefore did not form part of the general mass of the manuscripts which passed into Melzi's possession at Leonardi's death, since Vasari states that he kept these as though they were relics. As to whether this manuscript was identical with the work to which Fra Luca Pacioli referred, there is no sufficient evidence on which to form an opinion. Moreover, the Frate's testimony must not be interpreted too literally. The words of the dedication of the *De Divina Proportione* would naturally also suggest that the statue of Francesco Sforza was actually cast in bronze, but the general weight of evidence,

including that of Leonardo's own letters, forbids any such supposition. So, in like manner, it may perhaps have been that in the case of the *Treatise on Painting* he may have spoken of the rough drafts and fragments as though they were the completed work.

The work itself grew continually in the mind of the author. It was moulded and recast times without number as his purpose changed and expanded in his progress along each new avenue of study that revealed afresh the kinship of art and nature. It is certain that he never wrote 'finis.' It is at any rate possible that he never halted in investigation for so long time as would be necessary to arrange and classify what he had written—that he left all this to a more convenient season. Genius, we should remember, is not apt to be synthetic.

NOTE.—In the references to the manuscripts which follow the following abbreviations occur :—

C. A. = Codice Atlantico.

A, *B*, etc., to *I*, and *K*, *L*, *M* = MSS. *A*, *B*, etc., to *I*, and *K*, *L*, *M* of the Library of the Institut de France.

MSS. 2037 and 2038 *Bib. Nat.* = Nos. 2037 and 2038, Italian MSS. Bibliothèque Nationale.

Tr. = Codice Trivulziano.

B. M. 263 *Ar.* = British Museum, Arundel MSS. No. 263.

S. K. M. i-iii = South Kensington Museum (Forster Bequest) MSS. I-III.

Leic. = MS. in possession of Earl of Leicester.

R. = Richter, J. P., Literary Works of L. da V.

PROEM

SEEING that I cannot choose any subject of great utility or pleasure, because my predecessors have already taken as their own all useful and necessary themes, I will do like one who, because of his poverty, is the last to arrive at the fair, and not being able otherwise to provide himself, chooses all the things which others have already looked over and not taken, but refused as being of little value. With these despised and rejected wares—the leavings of many buyers—I will load my modest pack, and therewith take my course, distributing, not indeed amid the great cities, but among the mean hamlets, and taking such reward as befits the things I offer.

(*C. A.* 119 *v. a.*)

I am fully aware that the fact of my not being a man of letters may cause certain arrogant persons to think that they may with reason censure me, alleging that I am a man ignorant of book-learning. Foolish folk! Do they not know that I might retort by saying, as did Marius to the Roman Patricians, 'They who themselves go about adorned in the labour of others will not permit me my own.' They will say that because of my lack of book-learning, I cannot properly express what I desire to treat of.

Do they not know that my subjects require for their exposition experience rather than the words of others? And since experience has been the mistress of whoever has written well, I take her as my mistress, and to her in all points make my appeal.

(*C. A.* 119 *v. a.*)

BOOK I

LIFE

Thou, O God, dost sell unto us all good things at the price of labour. (*Windsor MSS. R* 1133.)

I obey thee, O Lord, first because of the love which I ought reasonably to bear thee; secondly, because thou knowest how to shorten or prolong the lives of men. (*S. K. M. iii.* 29 *r.*)

Our body is subject to heaven, and heaven is subject to the spirit. (*Tr. Tav.* 65 *a.*)

The soul desires to dwell in the body because without the members of that body it can neither act nor feel. (*C. A.* 59 *r. b.*)

How admirable thy justice, O thou first mover! Thou hast not willed that any power should lack the processes or qualities necessary for its results. (*A* 24 *r.*)

Instrumental or mechanical science is the noblest and above all others the most useful, seeing that by means of it all animated bodies which have movement perform all their actions; and the origin of these movements is at the centre of their gravity, which is placed in the middle with unequal weights at the sides of it, and it has

scarcity or abundance of muscles and also the action of a lever and counter lever. (*Sul volo degli Uccelli*, 3 *r.*)

The soul can never be infected by the corruption of the body, but acts in the body like the wind which causes the sound of the organ, wherein if one of the pipes is spoiled, the wind cannot produce a good result in that pipe. (*Tr. Tav.* 71 *a.*)

Whoever would see in what state the soul dwells within the body, let him mark how this body uses its daily habitation, for if this be confused and without order, then will the body be kept in disorder and confusion by the soul. (*C. A.* 76 *r. a.*)

Music has two ills, the one mortal, the other wasting; the mortal is ever allied with the instant which follows that of the music's utterance, the wasting ill lies in its repetition, making it seem contemptible and mean.
(*C. A.* 382 *v. a.*)

The imitation of the antique is more to be praised than that of the modern. (*C. A.* 147 *r. a.*)

In life beauty perishes, not in art. (*S. K. M. iii.* 72 *r.*)

The painter contends with and rivals nature.
(*S. K. M. iii.* 44 *v.*)

The senses are of the earth, the reason stands apart from them in contemplation. (*Tr. Tav.* 60 *a.*)

Where there is most power of feeling, there of martyrs is the greatest martyr. (*Tr. Tav.* 35 *a.*)

Tears come from the heart not from the brain.

(*Windsor MSS. R* 815.)

Why does the eye see a thing more clearly in dreams than the imagination when awake?

(*B. M.* 263, *Ar.* 278 *v.*)

What is it that is much desired by men, but which they know not while possessing? It is sleep.

(*I* 56 [8] *r.*)

The thoughts turn towards hope. (*C. A.* 68 *v. b.*)

Pray hold me not in scorn! I am not poor! Poor rather is the man who desires many things. Where shall I take my place? Where in a little time from henceforth you shall know. Do you answer for yourself! From henceforth in a little time. . .

(*C. A.* 71 *r. a.*)

Vows begin when hope dies. (*H* 48 *v.*)

If liberty is dear to you may you never discover that my face is love's prison. (*S. K. M. iii.* 10 *v.*)

The lover is drawn by the thing loved, as the sense is by that which it perceives, and it unites with it, and they become one and the same thing. The work is the first thing born of the union; if the thing that is loved be base, the lover becomes base. When the thing taken into union is in harmony with that which receives it, there follow rejoicing and pleasure and satisfaction. When the lover is united to that which is loved it finds rest there: when the burden is laid down there it finds rest. (*Tr. Tav.* 9 *a.*)

Behold now the hope and desire to go back to our own country, and to return to our former state, how like it is to the moth with the light! And the man who with perpetual longing ever looks forward with joy to each new spring and each new summer, and to the new months and the new years, deeming that the things he longs for are too slow in coming, does not perceive that he is longing for his own destruction. But this longing is the quintessence and spirit of the elements, which, finding itself imprisoned within the life of the human body,[1] desires continually to return to its source. And I would have you to know that this very same longing is that quintessence inherent in nature, and that man is a type of the world. (*B. M.* 263, *Ar.* 156 *v.*)

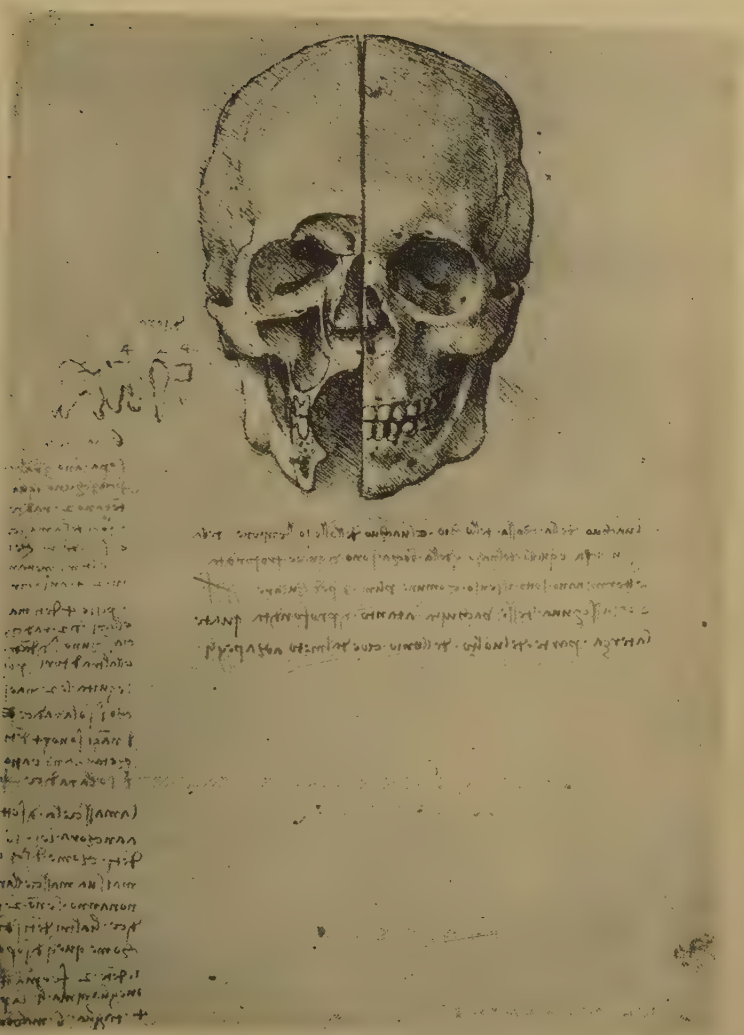
In youth acquire that which may requite you for the deprivations of old age; and if you are mindful that old age has wisdom for its food, you will so exert yourself in youth, that your old age will not lack sustenance.

(*C. A.* 112 *r. a.*)

We have no lack of system or device to measure and to parcel out these poor days of ours; wherein it should be our pleasure that they be not squandered or suffered to pass away in vain, and without meed of honour, leaving no record of themselves in the minds of men; to the end that this our poor course may not be sped in vain. (*C. A.* 12 *v. a.*)

O thou that sleepest, what is sleep? Sleep is an image of death. Oh, why not let your work be such that

[1] MS. 'dello vmano chorpo.'



STUDY OF A SKULL IN SECTION

TO SHOW THE BONY CAVITIES OF THE FACE

Face p. 50

after death you become an image of immortality; as in life you become when sleeping like unto the hapless dead. (*C. A.* 76 *v. a.*)

Every evil leaves a sorrow in the memory except the supreme evil, death, and this destroys memory itself together with life. (*H* 33 *v.*)

As a well-spent day brings happy sleep, so life well used brings happy death. (*Tr. Tav.* 28 *a.*)

While I thought that I was learning how to live, I have been learning how to die. (*C. A.* 252 *r. a.*)

The age as it flies glides secretly and deceives one and another; nothing is more fleeting than the years, but he who sows virtue reaps honour. (*C. A.* 71 *v. a.*)

Iron rusts from disuse; stagnant water loses its purity and in cold weather becomes frozen; even so does inaction sap the vigour of the mind. (*C. A.* 289 *v. c.*)

Life well spent is long. (*Tr. Tav.* 63 *a.*)

In rivers, the water that you touch is the last of what has passed and the first of that which comes: so with time present. (*Tr. Tav.* 63 *a.*)

Wrongfully do men lament the flight of time, accusing it of being too swift, and not perceiving that its period is yet sufficient; but good memory wherewith nature has endowed us causes everything long past to seem present. (*C. A.* 76 *r. a.*)

Our judgment does not reckon in their exact and proper order things which have come to pass at different periods of time; for many things which happened many years ago will seem nearly related to the present, and many things that are recent will seem ancient, extending back to the far-off period of our youth. And so it is with the eye, with regard to distant things, which when illumined by the sun seem near to the eye, while many things which are near seem far off. (*C. A.* 29 *v. a.*)

O Time, thou that consumest all things! O envious age, thou destroyest all things and devourest all things with the hard teeth of the years, little by little, in slow death! Helen, when she looked in her mirror and saw the withered wrinkles which old age had made in her face, wept, and wondered to herself why ever she had twice been carried away.

O Time, thou that consumest all things! O envious age, whereby all things are consumed!

(*C. A.* 71 *r. a.*)

Just as eating contrary to the inclination is injurious to the health, so study without desire spoils the memory, and it retains nothing that it takes in.

(*MS.* 2038, *Bib. Nat.* 34 *r.*)

Wood feeds the fire that consumes it.

(*MS.* 2038, *Bib. Nat.* 34 *v.*)

Call not that riches which may be lost; virtue is our true wealth, and the true reward of its possessor. It cannot be lost; it will not abandon us unless life itself first leaves us. As for property and material wealth,

these you should ever hold in fear; full often they leave their possessor in ignominy mocked at for having lost possession of them. (*MS.* 2038, *Bib. Nat.* 34 *v.*)

HOW IN ALL TRAVELS ONE MAY LEARN

This benign nature so provides that all over the world you find something to imitate.

(*MS.* 2038, *Bib. Nat.* 31 *v.*)

The supreme misfortune is when theory outstrips performance. (*MS.* 2038, *Bib. Nat.* 33 *v.*)

The natural desire of good men is knowledge.

(*C. A.* 119 *v. a.*)

The knowledge of past time and of the position of the earth is the adornment and the food of human minds.

(*C. A.* 373 *v. a.*)

Nothing can be written as the result of new researches.

(*Tr. Tav.* 52 *a.*)

All our knowledge originates in opinions.

(*Tr. Tav.* 41 *a.*)

Shun those studies in which the work that results dies with the worker. (*S. K. M. iii.* 55 *r.*)

The idea or the faculty of imagination is both rudder and bridle to the senses, inasmuch as the thing imagined moves the sense.

Pre-imagining is the imagining of things that are to be.

Post-imagining is the imagining of things that are past. (*Windsor MSS. Dell' Anat. Fogli B* 2 *v.*)

Whoever in discussion adduces authority uses not intellect but rather memory. (*C. A.* 76 *r. a.*)

Good literature proceeds from men of natural probity, and since one ought rather to praise the inception than the result, you should give greater praise to a man of probity unskilled in letters than to one skilled in letters but devoid of probity. (*C. A.* 76 *r. a.*)

Poor is the pupil who does not surpass his master. (*S. K. M. iii.* 66 *v.*)

Science is the captain, practice the soldiers. (*I* 130 [82] *r.*)

To devise is the work of the master, to execute the act of the servant. (*C. A.* 109 *v. a.*)

Every part is disposed to unite with the whole, that it may thereby escape from its own incompleteness. (*C. A.* 59 *r. b.*)

There is no certainty where one can neither apply any of the mathematical sciences nor any of those which are based upon the mathematical sciences. (*G* 96 *v.*)

You who speculate on the nature of things, I praise you not for knowing the processes which nature ordinarily effects of herself, but rejoice if so be that you know the issue of such things as your mind conceives. (*G* 47 *r.*)

There is no result in nature without a cause; understand the cause and you will have no need of the experiment. (*C. A.* 147 *v. a.*)

The lying interpreters of nature assert that mercury is a common factor in all the metals; they forget that nature varies its factors according to the variety of the things which it desires to produce in the world.

(*C. A.* 76 *v. a.*)

Nature never breaks her own law. (*E* 43 *v.*)

Nature is constrained by the order of her own law which lives and works within her. (*C* 23 *v.*)

Necessity is the mistress and guide of nature. Necessity is the theme and artificer of nature, the bridle and the eternal law. (*S. K. M. iii.* 43 *v.*)

Weight, pressure, and accidental movement together with resistance are the four accidental powers in which all the visible works of mortals have their existence and their end. (*S. K. M. ii.* 116 *v.*)

Every weight tends to fall towards the centre by the shortest way. (*C* 28 *v.*)

All the elements when removed from their natural place desire to return there, especially fire, water, and earth. (*C* 26 *v.*)

O mathematicians, throw light on this error. The spirit has not voice, for where there is voice there is a body, and where there is a body there is occupation of space which prevents the eye from seeing things situated beyond this space; consequently this body of itself fills the whole surrounding air, that is by its images.

(*C. A.* 190 *v. b.*)

HOW THE MOVEMENTS OF THE EYE, THE RAY OF THE SUN AND THE MIND ARE THE SWIFTEST THAT CAN BE

The sun so soon as ever it appears in the east instantly proceeds with its rays to the west; and these are made up of three incorporeal forces, namely radiance, heat, and the image of the shape which produces these.

The eye so soon as ever it is opened beholds all the stars of our hemisphere.

The mind passes in an instant from the east to the west; and all the great incorporeal things resemble these very closely in their speed. (*C. A.* 204 *v. a.*)

A PROOF OF HOW OBJECTS COME TO THE EYE

After looking at the sun or other luminous object and then closing the eyes you will continue to see it as before within the eye for a considerable space of time. This is a token that the images enter within the eye.

(*C. A.* 204 *r. a.*)

Just as a stone flung into the water becomes the centre and cause of various circles, and a sound produced in the air spreads itself out in circles, so each body situated in the luminous air is spread out circle-wise and fills the surrounding parts with infinite images of itself and is present all in the whole and all in every part.

(*A* 9 *v.*)

Experience is never at fault; it is only your judgment that is in error in promising itself such results from experience as are not caused by our experiments. For having given a beginning, what follows from it must necessarily be a natural development of such a beginning,

unless it has been subject to a contrary influence, while, if it is affected by any contrary influence, the result which ought to follow from the aforesaid beginning will be found to partake of this contrary influence in a greater or less degree in proportion as the said influence is more or less powerful than the aforesaid beginning.

(*C. A.* 154 *r. a.*)

Experience is not at fault; it is only our judgment that is in error in promising itself from experience things which are not within her power.

Wrongly do men cry out against experience and with bitter reproaches accuse her of deceitfulness. Let experience alone, and rather turn your complaints against your own ignorance, which causes you to be so carried away by your vain and insensate desires as to expect from experience things which are not within her power!

Wrongly do men cry out against innocent experience, accusing her often of deceit and lying demonstrations!

(*C. A.* 154 *v. a.*)

Nature is full of infinite causes which were never set forth in experience. (*I* 18 *r.*)

I reveal to men the origin of the first, or perhaps the second, cause of their existence.

(*Windsor MSS. R* 841.)

Falsehood is so utterly vile that though it should praise the great works of God it offends against His divinity; truth is of such excellence that if it praise the meanest things they become ennobled.

Without doubt truth stands to falsehood in the relation

of light to darkness, and truth is in itself of such excellence that even when it treats of humble and lowly matters it yet immeasurably outweighs the sophistries and falsehoods which are spread out over great and high-sounding discourses; for though we have set up falsehood as a fifth element in our mental state it yet remains that the truth of things is the chief food of all finer intellects—though not indeed of wandering wits.

But you who live in dreams—the specious reasonings, the feints which *palla* players might use, if only they treat of things vast and uncertain, please you more than do the things which are sure and natural and of no such high pretension. (*Sul Volo degli Uccelli*, 12 *r.*)

The line that is straightest offers most resistance. (*Tr. Tav.* 24 *a.*)

He who has most possessions should have the greatest fear of loss. (*C. A.* 109 *v. a.*)

Supreme happiness will be the greatest cause of misery, and the perfection of wisdom the occasion of folly. (*C. A.* 39 *v. c.*)

As courage endangers life even so fear preserves it.

Threats only serve as weapons to the threatened.

Who walks rightly seldom falls.

You do ill if you praise, but worse if you censure what you do not rightly understand. (*C. A.* 76 *v. a.*)

Who goes not ever in fear sustains many injuries and often repents. (*C. A.* 170 *r. b.*)

To speak well of a worthless man is like speaking ill of a good man. (*S. K. M. iii.* 41 *v.*)

Folly is the buckler of shame as importunity is of poverty. (*Tr. Tav.* 52 *a.*)

Fear springs to life more quickly than anything else. (*L* 90 *v.*)

As evil that harms me not even so is good which does not profit me.

Who injures others regards not himself. (*M* 4 *r.*)

Truth alone was the daughter of time. (*M* 58 *v.*)

He who does not value life deserves it not. (*I* 15 *r.*)

Ask counsel of him who governs himself well.

Justice requires power, intelligence, and will. It resembles the queen bee.

He who neglects to punish evil sanctions the doing thereof.

He who takes the snake by the tail is afterwards bitten by it.

He who digs the pit upon him will it fall in ruin. (*H* 118 [25 *r.*] *v.*)

He who thinks little makes many mistakes.

No counsel is more trustworthy than that which is given upon ships that are in peril.

Let him expect disaster who shapes his course on a young man's counsel. (*H* 119 [24 *v.*] *r.*)

He who expects from experience what she does not possess takes leave of reason. (*C. A.* 299 *r. b.*)

Happy is that estate which is seen by the eye of its lord.

This by experience is proved, that he who never puts his trust in any man will never be deceived.
(*C. A.* 344 *r. b.*)

The memory of benefits is frail as against ingratitude.

Reprove a friend in secret but praise him before others.

He who walks in fear of dangers will not perish in consequence thereof.

Lie not about the past. (*H* 16 *v.*)

Bars of gold are refined in the fire. (*H* 98 [44 *bis v.*] *r.*)

It is by testing that we discern fine gold.

As is the mould so will be the cast.
(*H* 100 [43 *r.*] *v.*)

Every wrong shall be set right. (*H* 99 [44 *v.*] *r.*)

Constancy. Not he who begins, but he who perseveres.
(*H* 101 [42 *v.*] *r.*)

He who strips the wall bare on him will it fall.

He who cuts down the tree on him it takes vengeance in its fall. (*H* 118 [25 *v.*] *r.*)

Obstacles cannot bend me.

Every obstacle yields to effort.

He who fixes his course by a star changes not.
(*Windsor MSS. R* 682.)

A SIMILE OF PATIENCE

Patience serves as a protection against wrongs as clothes do against cold. For if you put on more clothes as the cold increases it will have no power to hurt you. So in like manner you must grow in patience when you meet with great wrongs, and they will then be powerless to vex your mind. (*C. A.* 117 *v. b.*)

When fortune comes seize her with a firm hand,—in front, I counsel you, for behind she is bald.
(*C. A.* 76 *v. a.*)

A simile. A vessel of unbaked clay when broken may be remoulded, but not one that has passed through the fire. (*Tr. Tav.* 68 *a.*)

Fame should be represented in the shape of a bird, but with the whole figure covered with tongues instead of feathers. (*B* 3 *v.*)

Where fortune enters, there envy lays siege, and strives against it, and when this departs it leaves anguish and remorse behind. (*C. A.* 76 *v. a.*)

Envy wounds by base calumnies, that is by slander, at which virtue is filled with dismay. (*H* 60 [12] *v.*)

Good Report soars and rises up to heaven, for virtuous things find favour with God. Evil Report should be shown inverted, for all her works are contrary to God and tend towards hell. (*H* 61 [13] *r.*)

This envy is represented making a contemptuous

motion towards heaven, because if she could she would use her strength against God. She is made with a mask upon her face of fair appearance. She is made wounded in the sight by palm and olive. She is made wounded in the ear by laurel and myrtle to signify that victory and truth offend her. She is made with many lightnings issuing forth from her to denote her evil speaking. She is made lean and wizened because she is ever wasting in perpetual desire. She is made with a fiery serpent gnawing at her heart. She is given a quiver with tongues for arrows, because with the tongue she often offends, and she is made with a leopard's skin, since the leopard from envy slays the lion by guile. She is given a vase in her hand full of flowers, and beneath these filled with scorpions and toads and other venomous things. She is made riding upon death, because envy never dying has lordship over him; and death is made with a bridle in his mouth and laden with various weapons, since these are all the instruments of death.

(*Oxford Drawings, Part ii. No.* 6.)

In the moment when virtue is born she gives birth to envy against herself, and a body shall sooner exist without a shadow than virtue without envy.

(*Oxford Drawings, Part ii. No.* 6.)

Pleasure and Pain are represented as twins, as though they were joined together, for there is never the one without the other; and they turn their backs because they are contrary to each other.

If you shall choose pleasure know that he has behind him one who will deal out to you tribulation and repentance.

This is pleasure together with pain, and they are represented as twins because the one is never separated from the other. They are made with their backs turned to each other because they are contrary the one to the other. They are made growing out of the same trunk because they have one and the same foundation, for the foundation of pleasure is labour with pain, and the foundations of pain are vain[1] and lascivious pleasures. And accordingly it is represented here with a reed in the right hand which is useless and without strength [?] and the wounds made with it are poisoned. In Tuscany reeds are put to support beds to signify that here occur vain dreams, and here is consumed a great part of life: here is squandered much useful time, namely that of the morning when the mind is composed and refreshed, and the body therefore is fitted to resume new labours. There also are taken many vain pleasures both with the mind imagining impossible things, and with the body taking those pleasures which are often the cause of the failing of life; so that for this the reed is held as representing such foundations.

(*Oxford Drawings, Part ii. No.* 7.)

Intellectual passion drives out sensuality.

(*C. A.* 358 *v. a.*)

Whoso curbs not lustful desires puts himself on a level with the beasts.

You can have neither a greater nor a less dominion than that over yourself.

[1] MS. 'vanj,' not 'varj.'

It is easier to resist at the beginning than at the end.

(*H* 119 [24 *v.*] *r.*)

If you kept your body in accordance with virtue your desires would not be of this world.

(*B* 3 *v.*)

Nothing is so much to be feared as a bad reputation. This bad reputation is caused by vices.

(*H* 40 *r.*)

You grow in reputation like bread in the hands of children. (*B* 3 *v.*)

Methinks that coarse men of bad habits and little power of reason do not deserve so fine an instrument or so great a variety of mechanism as those endowed with ideas and with great reasoning power, but merely a sack wherein their food is received, and from whence it passes away. For in truth one can only reckon them as a passage for food; since it does not seem to me that they have anything in common with the human race except speech and shape, and in all else they are far below the level of the beasts.

(*Windsor MSS. Dell' Anat. Fogli B* 21 *v.*)

And this man excels in folly who continually stints himself in order that he may not want, and his life slips away while he is still looking forward to enjoying the wealth which by extreme toil he has acquired.

(*S. K. M. iii.* 17 *v.*)

O speculators about perpetual motion, how many vain chimeras have you created in the like quest? Go and take your place with the seekers after gold.

(*S. K. M. ii.* 92 *v.*)

O misery of man! To how many things do you make yourself a slave for money?

(*Windsor MSS. R* 688.)

To the ambitious, whom neither the boon of life nor the beauty of the world suffice to content, it comes as penance that life with them is squandered, and that they possess neither the benefits nor the beauty of the world.

(*C. A.* 91 *v. a.*)

Strive to preserve your health; and in this you will the better succeed in proportion as you keep clear of the physicians, for their drugs are a kind of alchemy concerning which there are no fewer books than there are medicines. (*Windsor MSS. Dell' Anat. Fogli A* 2 *r.*)

Every man desires to acquire wealth in order that he may give it to the doctors, the destroyers of life; therefore they ought to be rich. (*F* 96 *v.*)

Wine is good, but water is preferable at table.

(*I* 122 [74] *v.*)

Here nature seems in many or for many animals to have been rather a cruel step-mother than a mother, and for some not a step-mother but a compassionate mother.

(*S. K. M. iii.* 20 *v.*)

We support life by the death of others.

In dead matter there remains insensible life, which on becoming re-united to the stomachs of the living resumes the life of the senses and of the intellect.

(*H* 89 [41] *v.*)

Man and the animals are merely a passage and channel

for food, a tomb for other animals, a haven for the dead, giving life by the death of others, a coffer full of corruption. (*C. A.* 76 *v. a.*)

Man has great power of speech, but the greater part thereof is empty and deceitful. The animals have little, but that little is useful and true[1]; and better is a small and certain thing than a great falsehood. (*F* 96 *v.*)

Lust is the cause of generation.

Appetite is the stay of life.

Fear or timidity is the prolongation of life.

Deceit is the preservation of the instrument.

(*H* 32 *r.*)

Let the street be as wide as the universal height of the houses. (*B* 36 *r.*)

When besieged by ambitious tyrants, I find a means of offence and defence in order to preserve the chief gift of nature, which is liberty; and first I would speak of the position of the walls, and then of how the various peoples can maintain their good and just lords.

(*MS.* 2037, *Bib. Nat.* 10 *r.*)

Small rooms or dwellings set the mind in the right path, large ones cause it to go astray.

(*MS.* 2038, *Bib. Nat.* 16 *r.*)

If you cause your ship to stop, and place the head of a long tube in the water, and place the other extremity to your ear you will hear ships at a great distance from you.

[1] *i.e.* 'vero' (the reading adopted by Dr. Richter). MS. has 'verso.'

You can also do the same by placing the head of the tube upon the ground, and you will then hear any one passing at a distance from you. (*B* 6 *r.*)

A WAY OF SAVING ONESELF IN A TEMPEST OR SHIPWRECK AT SEA

It is necessary to have a coat made of leather with a double hem over the breast of the width of a finger, and double also from the girdle to the knee, and let the leather of which it is made be quite air-tight. And when you are obliged to jump into the sea, blow out the lappets of the coat through the hems of the breast, and then jump into the sea. And let yourself be carried by the waves, if there is no shore near at hand and you do not know the sea. And always keep in your mouth the end of the tube through which the air passes into the garment; and if once or twice it should become necessary for you to take a breath when the foam prevents you, draw it through the mouth of the tube from the air within the coat. (*B* 81 *v.*)

Words which fail to satisfy the ear of the listener always either fatigue or weary him; and you may often see a sign of this when such listeners are frequently yawning. Consequently when addressing men whose good opinion you desire, either cut short your speech when you see these evident signs of impatience, or else change the subject; for if you take any other course, then in place of the approbation you desire you will win dislike and ill-will.

And if you would see in what a man takes pleasure

without hearing him speak, talk to him and change the subject of your discourse several times, and when it comes about that you see him stand fixedly without either yawning or knitting his brows or making any other movement, then be sure that the subject of which you are speaking is the one in which he takes pleasure.

(*G* 49 *r.*)

But of all human discourses that must be considered as most foolish which affirms a belief in necromancy, which is the sister of alchemy, the producer of simple and natural things, but is so much the more worthy of blame than alchemy, because it never gives birth to anything whatever except to things like itself, that is to say lies; and this is not the case with alchemy, which works by the simple products of nature, but whose function cannot be exercised by nature herself, because there are in her no organic instruments with which she might be able to do the work which man performs with his hands, by the use of which he has made glass, etc. But this necromancy, an ensign, or flying banner, blown by the wind, is the guide of the foolish multitude, which is a continual witness by its clamour to the limitless effects of such an art. And they have filled whole books in affirming that enchantments and spirits can work and speak without tongues, and can speak without any organic instrument,—without which speech is impossible,—and can carry the heaviest weights, and bring tempests and rain, and that men can be changed into cats and wolves and other beasts, although those first become beasts who affirm such things.

And undoubtedly if this necromancy did exist, as is believed by shallow minds, there is nothing on the earth that would have so much power either to harm or benefit man : if it were true, that is, that by such an art one had the power to disturb the tranquil clearness of the air, and transform it into the hue of night, to create coruscations and tempests with dreadful thunder-claps and lightning-flashes rushing through the darkness, and with impetuous storms to overthrow high buildings and uproot forests, and with these to encounter armies and break and overthrow them, and—more important even than this—to make the devastating tempests, and thereby rob the husbandmen of the reward of their labours. For what method of warfare can there be which can inflict such damage upon the enemy as the exercise of the power to deprive him of his crops? What naval combat could there be which should compare with that which he would wage who has command of the winds and can create ruinous tempests that would submerge every fleet whatsoever? In truth, whoever has control of such irresistible forces will be lord over all nations, and no human skill will be able to resist his destructive power. The buried treasures, the jewels that lie in the body of the earth will all become manifest to him ; no lock, no fortress, however impregnable, will avail to save any one against the will of such a necromancer. He will cause himself to be carried through the air from East to West, and through all the uttermost parts of the universe. But why do I thus go on adding instance to instance? What is there which could not be brought to pass by a mechanician such as this? Almost nothing, except the escaping from death.

We have therefore ascertained in part the mischief and the usefulness that belong to such an art if it is real; and if it is real why has it not remained among men who desire so much, not having regard to any deity, merely because there are an infinite number of persons who in order to gratify one of their appetites would destroy God and the whole universe?

If then it has not remained among men, although so necessary to them, it never existed, and never can exist, as follows from the definition of a spirit, which is invisible and incorporeal, for within the elements there are no incorporeal things, because where there is not body there is a vacuum, and the vacuum does not exist within the elements, because it would be instantly filled up by the element.

(*Windsor MSS. Dell' Anat. Fogli B* 31 *v.*)

OF SPIRITS

We have just now stated on the other side of this page, that the definition of a spirit is a power united to a body, because of itself it can neither offer resistance nor take any kind of local movement; and if you say that it does in itself offer resistance, this cannot be so within the elements, because if the spirit is a quantity without a body, this quantity is what is called a vacuum, and the vacuum does not exist in nature, and granting that one were formed, it would be instantly filled up by the falling in of that element within which such a vacuum had been created. So by the definition of weight, which says that gravity is a fortuitous power created by one element being drawn or impelled towards another, it

follows that any element, though without weight when in the same element, acquires weight in the element above it, which is lighter than itself; so one sees that one part of the water has neither gravity nor levity in the rest of the water, but if you draw it up into the air then it will acquire weight, and if you draw the air under the water then the water on finding itself above this air acquires weight, which weight it cannot support of itself, and consequently its descent is inevitable, and therefore it falls into the water, at the very spot which had been left a vacuum by this water. The same thing would happen to a spirit if it were among the elements, for it would continually create a vacuum in whatever element it chanced to find itself; and for this reason it would be necessarily in perpetual flight towards the sky until it had passed out of these elements.

WHETHER THE SPIRIT HAS A BODY AMONG THE ELEMENTS

We have proved how the spirit cannot of itself exist among the elements without a body, nor yet move of itself by voluntary movement except to rise upwards. We now proceed to say that such a spirit in taking a body of air must of necessity spread itself through this air; for if it remained united, it would be separated from it and would fall, and so create a vacuum, as is said above; and therefore it is necessary, if it is to be able to remain suspended in the air, that it should spread itself over a certain quantity of air; and if it becomes mingled with the air two difficulties ensue, namely, that it rarefies

that quantity of air within which it is mingled, and consequently this air, becoming rarefied, flies upwards of its own accord, and will not remain among the air that is heavier than itself; and moreover, that as this aethereal essence is spread out, the parts of it become separated, and its nature becomes modified, and it thereby loses something of its former power. To these there is also added a third difficulty, and that is that this body of air assumed by the spirit is exposed to the penetrating force of the winds, which are incessantly severing and tearing in pieces the connected portions of the air, spinning them round and whirling them amid the other air; and therefore the spirit which was spread through this air would be dismembered or rent in pieces and broken, together with the rending in pieces of the air within which it was spread.

WHETHER THE SPIRIT HAVING ASSUMED A BODY OF AIR CAN MOVE OF ITSELF OR NO

It is impossible that the spirit diffused within a quantity of air can have power to move this air; and this is shown by the former section in which it is stated that the spirit rarefies that quantity of air within which it has entered. This air consequently will rise up above the other air, and this will be a movement made by the air through its own levity, and not through the voluntary movement of the spirit; and if this air meets the wind, by the third part of this section, this air will be moved by the wind and not by the spirit which is diffused within it.

WHETHER THE SPIRIT CAN SPEAK OR NO

Wishing to prove whether or no the spirit can speak, it is necessary first to define what voice is, and how it is produced, and we may define it as follows :—the voice is movement of air in friction against a compact body, or of the compact body in friction against the air, which is the same thing ; and this friction of compact with tenuous substance condenses the latter, and so makes it capable of resisting ; moreover, the tenuous substance, when in swift motion, and a similar substance moving slowly, condense each other at their contact, and make a noise or tremendous uproar ; and the sound or murmur caused by one tenuous substance moving through another at a moderate pace [is] like a great flame which creates noises within the air ; and the loudest uproar made by one tenuous substance with another is when the one swiftly moving penetrates the other which is unmoveable, as for instance the flame of fire issuing forth from the cannon and striking against the air, and also the flame issuing from the cloud, which strikes the air and so produces thunderbolts.

We may say therefore, that the spirit cannot produce a voice without movement of air, and there is no air within it, and it cannot expel air from itself if it has it not, and if it wishes to move that within which it is diffused, it becomes necessary that the spirit should multiply itself, and this it cannot do unless it has quantity. And by the fourth part it is said that no tenuous body can move unless it has a fixed spot from whence to take its motion, and especially in the case of an element moving in its

own element, which does not move of itself, except by uniform evaporation at the centre of the thing evaporated, as happens with a sponge squeezed in the hand, which is held under water, since the water flows away from it in every direction with equal movement through the openings that come between the fingers of the hand within which it is squeezed.

Of whether the spirit has articulate voice,—and whether the spirit can be heard,—and what hearing is, and seeing ; —and how the wave of the voice passes through the air,— and how the images of objects pass to the eye.—

(*Windsor MSS. Dell' Anat. Fogli B* 31 *r. and* 30 *v.*)

HOW THE FIVE SENSES ARE THE MINISTERS OF THE SOUL

The soul apparently resides in the seat of the judgment, and the judgment apparently resides in the place where all the senses meet, which is called the common sense ; and it is not all of it in the whole body as many have believed, but it is all in this part ; for if it were all in the whole, and all in every part, it would not have been necessary for the instruments of the senses to come together in concourse to one particular spot ; rather would it have sufficed for the eye to register its function of perception on its surface, and not to transmit the images of the things seen to the sense by way of the optic nerves ; because the soul—for the reason already given—would comprehend them upon the surface of the eye.

Similarly, with the sense of hearing, it would be

PLATE 2

STUDIES OF THE DELTOID MUSCLE OF THE SHOULDER
IN VARIOUS ASPECTS

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sufficient merely for the voice to resound in the arched recesses of the rock-like bone, which is within the ear, without there being another passage from this bone to the common sense, whereby the said mouth might address itself to the common judgment.

The sense of smell also is seen to be forced of necessity to have recourse to this same judgment.

The touch passes through the perforated tendons and is transmitted to this sense; these tendons proceed to spread out with infinite ramifications into the skin which encloses the body's members and the bowels. The perforating tendons carry impulse and sensation to the subject limbs; these tendons passing between the muscles and the sinews dictate to these their movement, and these obey, and in the act of obeying they contract, for the reason that the swelling reduces their length and draws with it the nerves, which are interwoven amid the particles of the limbs, and being spread throughout the extremities of the fingers, they transmit to the sense the impression of what they touch.

The nerves with their muscles serve the tendons, even as soldiers serve their leaders, and the tendons serve the common sense as the leaders their captain, and this common sense serves the soul as the captain serves his lord.

So therefore, the articulation of the bones obeys the nerve, and the nerve the muscle, and the muscle the tendon, and the tendon the common sense, and the common sense is the seat of the soul, and the memory is its monitor, and its faculty of receiving impressions serves as its standard of reference.

How the sense waits on the soul, and not the soul on the sense, and how where the sense that should minister to the soul is lacking, the soul in such a life lacks conception of the function of this sense as is seen in the case of a mute or one born blind.

(*Windsor MSS. Dell' Anat. Fogli B 2 r.*)

Although human subtlety makes a variety of inventions answering by different means to the same end, it will never devise an invention more beautiful, more simple, or more direct than does nature, because in her inventions nothing is lacking, and nothing is superfluous; and she needs no countervailing weights when she creates limbs fitted for movement in the bodies of the animals, but puts within them the soul of the body which forms them, that is the soul of the mother which first constructs within the womb the shape of the man, and in due time awakens the soul that is to be its inhabitant. For this at first remained asleep, in the guardianship of the soul of the mother, who nourishes and gives it life through the umbilical vein, with all its spiritual members, and so it will continue for such time as the said umbilical cord is joined to the placenta and the cotylidons by which the child is attached to the mother. And this is the reason why any wish or intense desire or fright experienced by the mother, or any other mental suffering, is felt more powerfully by the child than by the mother, for there are many cases in which the child loses its life from it.

This discourse does not properly belong here, but is necessary in treating of the structure of animated bodies;

and the rest of the definition of the soul I leave to the wisdom of the friars, those fathers of the people who by inspiration know all mysteries. I speak not against the sacred books, for they are supreme truth.

(*Windsor MSS. Études Anatomiques B* [*Rouveyre*] 8 *v.*)

HOW THE BODY OF THE ANIMAL CONTINUALLY DIES AND IS RENEWED

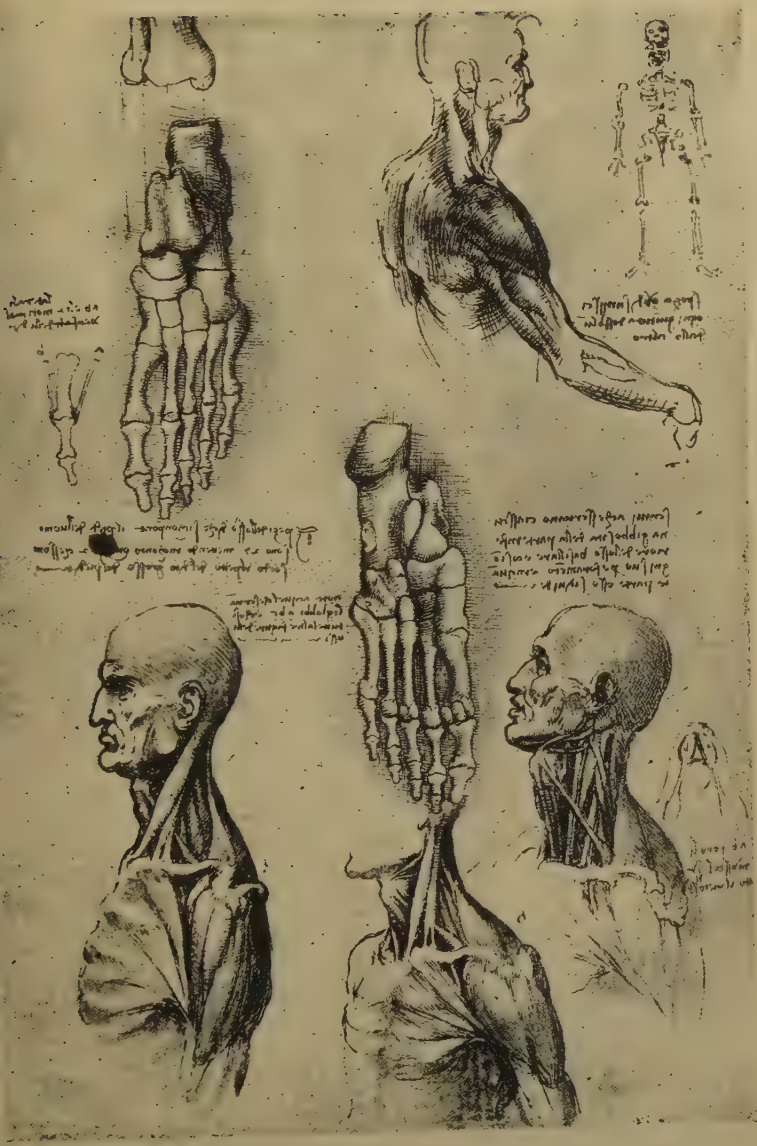
The body of anything whatsoever that receives nourishment continually dies and is continually renewed. For the nourishment cannot enter except in those places where the preceding nourishment is exhausted, and if it is exhausted it no longer has life. Unless therefore you supply nourishment equivalent to that which has departed, the life fails in its vigour; and if you deprive it of this nourishment, the life is completely destroyed. But if you supply it with just so much as is destroyed day by day, then it renews its life just as much as it is consumed; like the light of this candle formed by the nourishment given to it by the fat of this candle, which light is also continually renewed by swiftest succour from beneath, in proportion as the upper part is consumed and dies, and in dying becomes changed from radiant light to murky smoke. And this death extends for so long as the smoke continues; and the period of duration of the smoke is the same as that of what feeds it, and in an instant the whole light dies and is entirely regenerated by the movement of that which nourishes it; and its life receives from it also its ebb and flow, as the flicker of its point serves to show us. The same process also comes

to pass in the bodies of the animals by means of the beating of the heart, whereby there is produced a wave of blood in all the veins, and these are continually either enlarging or contracting, because the expansion occurs when they receive the excessive quantity of blood, and the contraction is due to the departure of the excess of blood they have received; and this the beating of the pulse teaches us, when we touch the aforesaid veins with the fingers in any part whatsoever of the living body. But to return to our purpose, I say that the flesh of the animals is made anew by the blood which is continually produced by that which nourishes them, and that this flesh is destroyed and returns by the mesaraic arteries and passes into the intestines, where it putrifies in a foul and fetid death, as they show us in their deposits and steam like the smoke and fire which were given as a comparison.

(*Windsor MSS. Dell' Anat. Fogli B* 28 *r.*)

And this old man, a few hours before his death, told me that he had lived a hundred years, and that he did not feel any bodily ailment other than weakness, and thus while sitting upon a bed in the hospital of Santa Maria Nuova at Florence, without any movement or sign of anything amiss, he passed away from this life.

And I made an autopsy in order to ascertain the cause of so peaceful a death, and found that it proceeded from weakness through failure of blood and of the artery that feeds the heart and the other lower members, which I found to be very parched and shrunk and withered; and the result of this autopsy I wrote down very carefully



STUDIES IN THE ANATOMY OF THE NECK AND OF THE BONES OF THE FOOT

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and with great ease, for the body was devoid of either fat or moisture, and these form the chief hindrance to the knowledge of its parts.

The other autopsy was on a child of two years, and here I found everything the contrary to what it was in the case of the old man.

The old who enjoy good health die through lack of sustenance. And this is brought about by the passage to the mesaraic veins becoming continually restricted by the thickening of the skin of these veins; and the process continues until it affects the capillary veins, which are the first to close up altogether; and from this it comes to pass that the old dread the cold more than the young, and that those who are very old have their skin the colour of wood or of dried chestnut, because this skin is almost completely deprived of sustenance.

And this network of veins acts in man as in oranges, in which the peel becomes thicker and the pulp diminishes the more they become old. And if you say that as the blood becomes thicker it ceases to flow through the veins, this is not true, for the blood in the veins does not thicken because it continually dies and is renewed.

(*Windsor MSS. Dell' Anat. Fogli B* 10 *v.*)

THE NATURE OF THE VEINS

The origin of the sea is the contrary to that of the blood, for the sea receives within itself all the rivers, which are entirely caused by the aqueous vapours that have ascended up into the air; while the sea of the blood is the source of all the veins.

OF THE NUMBER OF THE VEINS

The vein is one whole, which is divided into as many main branches as there are principal places which it has to nourish, and these branches are subdivided in an infinite number. (*Windsor MSS. Dell' Anat. Fogli A* 4 *r.*)

OF THE MUSCLES WHICH MOVE THE TONGUE

No member needs so great a number of muscles as the tongue,—twenty-four of these being already known apart from the others which I have discovered; and of all the members which are moved by voluntary action this exceeds all the rest in the number of its movements.

And if you shall say that this is rather the function of the eye, which receives all the infinite varieties of form and colour of the objects set before it, and of the smell with its infinite mixture of odours, and of the ear with its sounds, we may reply that the tongue also perceives an infinite number of flavours both simple and compounded; but this is not to our purpose, for our intention is to treat only of the particular movement of each member.

Consider carefully how by the movement of the tongue, with the help of the lips and teeth, the pronunciation of all the names of things is known to us; and how, by means of this instrument, the simple and compound words of a language arrive at our ears; and how these, if there were a name for all the effects of nature, would approach infinity in number, together with all the countless things which are in action and in the power of nature; and these would not be expressed in one language

only, but in a great number of languages, and these also would tend to infinite variety, because they vary continually from century to century, and in one country and another, through the intermingling of the peoples, who by wars or other mischances are continually becoming mixed with each other; and these same languages are liable to pass into oblivion, and they are mortal like all the rest of created things; and if we grant that our world is everlasting we shall then say that these languages have been, and still must be, of infinite variety, through the infinite number of centuries which constitute infinite time.

Nor is this true in the case of any other sense; for these are concerned only with such things as nature is continually producing, and she does not change the ordinary kinds of the things which she creates in the same way that from time to time the things are changed which have been created by man; and indeed man is nature's chiefest instrument, because nature is concerned only with the production of elementary things, but man from these elementary things produces an infinite number of compounds, although he has no power to create any natural thing except another like himself, that is his children. And of this the old alchemists will serve as my witnesses, who have never either by chance or deliberate experiment succeeded in creating the smallest thing which can be created by nature; and indeed this generation deserves unmeasured praises for the serviceableness of the things which they have invented for the use of men, and would deserve them even more if they had not been the inventors of noxious things like poisons and other similar things which destroy the life or the

intellect; but they are not exempt from blame in that by much study and experiment they are seeking to create, not, indeed, the meanest of nature's products, but the most excellent, namely gold, which is begotten of the sun inasmuch as it has more resemblance to it than to anything else that is, and no created thing is more enduring than this gold. It is immune from destruction by fire, which has power over all the rest of created things, reducing them to ashes, glass, or smoke. If, however, insensate avarice should drive you into such error, why do you not go to the mines where nature produces this gold, and there become her disciple? She will completely cure you of your folly by showing you that nothing which you employ in your furnace will be numbered among the things which she employs in order to produce this gold. For there is there no quicksilver, no sulphur of any kind, no fire nor other heat than that of nature giving life to our world; and she will show you the veins of the gold spreading through the stone,—the blue lapis lazuli, whose colour is unaffected by the power of the fire. And consider carefully this ramification of the gold, and you will see that the extremities of it are continually expanding in slow movement, transmuting into gold whatever they come in contact with; and note that therein is a living organism which it is not within your power to produce.

(*Windsor MSS. Dell' Anat. Fogli B* 28 *v.*)

And thou, man, who by these my labours dost look upon the marvellous works of nature, if thou judgest it to be an atrocious act to destroy the same, reflect that

it is an infinitely atrocious act to take away the life of man. For thou shouldst be mindful that though what is thus compounded seem to thee of marvellous subtlety, it is as nothing compared with the soul that dwells within this structure; and in truth, whatever this may be, it is a divine thing which suffers it thus to dwell within its handiwork at its good pleasure, and wills not that thy rage or malice should destroy such a life, since in truth he who values it not does not deserve it.

For we part from the body with extreme reluctance, and I indeed believe that its grief and lamentation are not without cause.

(*Windsor MSS. Dell' Anat. Fogli A 2 r.*)

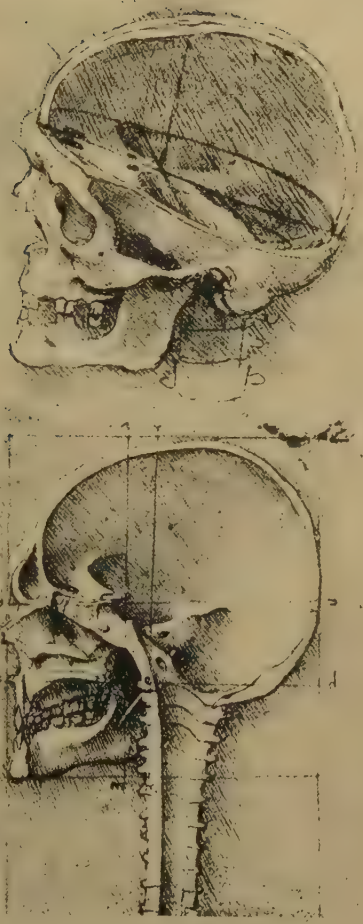
I wish to work miracles;—I may have less than other men who are more tranquil, or than those who aim at growing rich in a day. I may live for a long time in dire poverty as happens, and to all eternity will happen, to the alchemists, the would-be creators of gold and silver, and to the mechanicians who attempt to make dead water stir itself into life in perpetual motion, and to those consummate fools, the necromancer and the enchanter.

And you who say that it is better to look at an anatomical demonstration than to see these drawings, you would be right, if it were possible to observe all the details shown in these drawings in a single figure, in which, with all your ability, you will not see nor acquire a knowledge of more than some few veins, while, in order to obtain an exact and complete knowledge of these, I have dissected more than ten human bodies,

destroying all the various members, and removing even the very smallest particles of the flesh which surrounded these veins without causing any effusion of blood other than the imperceptible bleeding of the capillary veins. And, as one single body did not suffice for so long a time, it was necessary to proceed by stages with so many bodies as would render my knowledge complete; and this I repeated twice over in order to discover the differences.

But though possessed of an interest in the subject you may perhaps be deterred by natural repugnance, or, if this does not restrain you, then perhaps by the fear of passing the night-hours in the company of these corpses, quartered and flayed and horrible to behold; and. if this does not deter you, then perhaps you may lack the skill in drawing essential for such representation; and even if you possess this skill it may not be combined with a knowledge of perspective, while, if it is so combined, you may not be versed in the methods of geometrical demonstration or the method of estimating the forces and strength of muscles, or perhaps you may be found wanting in patience so that you will not be diligent. Concerning which things, whether or no they have all been found in me, the hundred and twenty books which I have composed will give their verdict 'yes' or 'no'; in these I have not been hindered either by avarice or negligence but only by want of time. Farewell.

(*Winasor MSS. Études Anatomiques Recueil B* (*Rouveyre*) 7 *v.*)



STUDIES OF A SKULL IN MEDIAN SECTION

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BOOK II

NATURE

PRAISE OF THE SUN

If you look at the stars without their rays,—as may be done by looking at them through a small hole made with the extreme point of a fine needle and placed so as almost to touch the eye,—you will perceive these stars to be so small that nothing appears less; and in truth the great distance gives them a natural diminution, although there are many there which are a great many times larger than the star which is our earth together with the water. Think, then, what this star of ours would seem like at so great a distance, and then consider how many stars might be set longitudinally and latitudinally amid these stars which are scattered throughout this dark expanse. I can never do other than blame those many ancients who said that the sun was no larger than it appears,—among these being Epicurus; and I believe that such a theory is borrowed from the idea of a light set in our atmosphere equidistant from the centre [of the earth]; whoever sees it never sees it lessened in size at any distance, and the reasons of its size and potency I shall reserve for the Fourth Book.

But I marvel greatly that Socrates should have spoken

with disparagement of that body, and that he should have said that it resembled a burning stone, and it is certain that whoever opposes him in such an error can scarcely do wrong. I could wish that I had such power of language as should avail me to censure those who would fain extol the worship of men above that of the sun, for I do not perceive in the whole universe a body greater and more powerful than this, and its light illumines all the celestial bodies which are distributed throughout the universe.

All vital principle descends from it, since the heat there is in living creatures proceeds from this vital principle, and there is no other heat or light in the universe, as I shall show in the Fourth Book, and, indeed, those who have wished to worship men as gods, such as Jupiter, Saturn, Mars, and the like, have made a very grave error seeing that even if a man were as large as our earth he would seem like one of the least of the stars, which appears but a speck in the universe; and seeing also that these men are mortal and subject to decay and corruption in their tombs.

The *Spera*, and Marullo, and many others praise the Sun. (*F* 5 *r.* and 4 *v.*)

All the flowers which see the sun mature their seed, and not the others, that is those which see only the reflection of the sun. (*G* 37 *r.*)

That the atmosphere attracts to itself like a magnet all the images of the things which surround it, and not only their bodily shapes but also their nature, is clearly

to be seen in the case of the sun, which is a hot and luminous body. All the atmosphere which is exposed to its influence is charged in all its parts with light and heat, and it all receives within itself the shape of that which is the source of this heat and radiance and does the same also in each minutest part. The north star is shown to do the same by the needle of the compass; and each of the planets does the like without itself undergoing any diminution. Among the products of the earth the same is found to happen with musk and other scents. (*C. A.* 138 *v. b.*)

EXPLANATION OF WHY THE SUN SEEMS LARGER IN THE WEST

Certain mathematicians contend that the sun grows larger when it is setting, because the eye sees it continually through atmosphere of greater density, alleging that objects seen through mist and in water seem larger. To those I reply that this is not the case, for the things seen through the mist are similar in colour to those which are at a distance, but as they do not undergo the same process of diminution, they appear greater in size.

In the same way nothing seems larger in smooth water, and this you may prove by tracing upon a board which is placed under water.

The real reason why the sun grows larger is that every luminous body appears larger, as it is further away. (*A* 64 *v.*)

WHAT THE MOON IS

The moon is not luminous in itself, but it is well fitted to take the characteristics of light after the manner of the mirror or of water or any other shining body; and it grows larger in the East and in the West like the sun and the other planets, and the reason of this is that every luminous body grows larger as it becomes more remote.

It may be readily understood that every planet and star is further away from us when in the West than when it is overhead, by about three thousand five hundred [miles] according to the proof given at the side [of the page];[1] and if you see the sun or moon reflected in water which is near at hand it will seem to be the same size in the water as it does in the sky, while if you go away to the distance of a mile it will seem a hundred times as large. And if you see it reflected in the sea at the moment of its setting the image of the sun will seem to you to be more than ten miles long, because it will cover in this reflection more than ten miles of sea. And if you were where the moon is, it would appear to you that the sun was reflected over as much of the sea as it illumines in its daily course, and the land would appear amid this water like the dark spots that are upon the moon, which when looked at from the earth presents to mankind the same appearance that our earth would present to men dwelling in the moon.

OF THE NATURE OF THE MOON

When all that we can see of the moon is illuminated it gives us its maximum of light, and then from the

[1] Here the margin of the MS. contains a diagram representing the earth with the sun shown in two positions.

reflection of the rays of the sun which strike upon it and rebound towards us its ocean throws off less moisture to us, and the less light it gives the more it is harmful.

(*A* 64 *r.*)

THE SPOTS ON THE MOON

Some have said that vapours are given off from the moon after the manner of clouds, and are interposed between the moon and our eyes. If this were the case these spots would never be fixed either as to position or shape; and when the moon was seen from different points, even although these spots did not alter their position, they would change their shape, as does a thing which is seen on different sides. (*F* 84 *r.*)

OF THE SPOTS ON THE MOON

Others have said that the moon is made up of parts, some more, some less transparent, as though one part were after the manner of alabaster, and another like crystal or glass. It would then follow that when the rays of the sun struck the less transparent part the light would stay on the surface, and consequently the denser part would be illuminated, and the transparent part would reveal the shadows of its obscure depths. Thus then they define the nature of the moon, and this view has found favour with many philosophers, and especially with Aristotle; but nevertheless it is false, since in the different phases which the moon and the sun frequently present to our eyes we should be seeing these spots vary, and at one time they would appear dark and at another light. They would be dark when the sun is in the West

and the moon in the centre of the sky, because the transparent hollows would then be in shadow as far as the tops of their edges, since the sun could not cast its rays into the mouths of these same hollows; and they would appear bright at full moon, when the moon in the East faces the sun in the West; for then the sun would illumine even the lowest depths of these transparent parts, and, in consequence, as no shadow was created, the moon would not at such times reveal to us the above-mentioned spots, and so it would be, sometimes more sometimes less, according to the change in the position of the sun to the moon, and of the moon to our eyes, as I have said above. (*F* 84 *v.*)

It has also been said that the spots on the moon are created in the moon itself, by the fact of it being of varying thinness or density. If this were so, then in the eclipses of the moon the solar rays could pierce through some part where it is thin, as has been stated, but since we do not see this result the aforesaid theory is false.

Others say that the surface of the moon is smooth and polished, and that, like a mirror, it receives within itself the reflection of the earth. This theory is false, since the earth, when not covered by the water, presents different shapes from different points of view; so when the moon is in the East it would reflect other spots than when it is overhead or in the West, whereas the spots upon the moon, as seen at full moon, never change during the course which it makes in our hemisphere. A second reason is that an object reflected in a convex surface fills only a small part of the mirror, as is proved in perspec-

tive. The third reason is that when the moon is full it only faces half the orb of the illuminated earth, in which the ocean and the other waters shine brightly, while the land forms spots amid this brightness; and consequently the half of our earth would be seen girded round about by the radiance of the sea, which takes its light from the sun, and in the moon this reflection would be the least part of that moon. The fourth reason is that one radiant body cannot be reflected in another, and consequently as the sea derives its radiance from the sun, as does also the moon, it could not show the reflected image of the earth, unless one also saw reflected there separately the orb of the sun and of each of the stars which look down upon it. (*F* 85 *r.*)

HOW IF THE MOON IS POLISHED AND SPHERICAL THE IMAGE OF THE SUN UPON IT IS POWERFULLY LUMINOUS, AND IS ONLY ON A SMALL PART OF ITS SURFACE

You will see the proof of this by taking a ball of burnished gold and placing it in the darkness and setting a light at some distance from it. Although this illuminates about half the ball, the eye only sees it reflected on a small part of its surface, and all the rest of the surface reflects the darkness which surrounds it. For this reason it is only there that the image of the light is apparent, and all the rest remains invisible because the eye is at a distance from the ball. The same thing would happen with the surface of the moon if it were polished, glittering and solid, as are bodies which have a reflecting surface.

Show how if you were upon the moon or upon a star

our earth would appear to you to perform the same function for the sun as now the moon does. And show how the reflection of the sun in the sea cannot itself appear a sun as it does in a flat mirror. (*F* 93 *r.*)

OF THE CIRCLES OF THE MOON

I find that those circles which at night seem to surround the moon, varying in circumference and in their degree of redness, are caused by the different degrees of thickness of the vapours which are situated at different altitudes between the moon and our eyes. And the circle that is larger and less red is in the first part lower than the said vapours; the second, being less, is higher and appears redder, because it is seen through two sets of vapours; and so the higher they are the smaller and the redder will they appear, for between the eye and them there will be more layers of vapours, and this goes to prove that where there appears greater redness, there there is a greater quantity of vapours.

(*C. A.* 349 *v. e.*)

Why the thunder lasts for a longer time than that which causes it;—and why, immediately on its creation, the lightning becomes visible to the eye, while the thunder requires time to travel, after the manner of a wave, and makes the loudest noise when it meets with most resistance. (*K* 110 [30] *v.*)

THE ORDER OF THE FIRST BOOK ON WATER

Define first of all what is height and depth, also how the elements are situated one within the other. Then

what is solid weight and liquid weight; but first of all what weight and lightness consist of in themselves. Then describe why water moves, and why its motion ceases; then why it becomes slower or more rapid, and in addition to this how it continually descends when in contact with air that is lower than itself; and how the water rises in the air through the heat of the sun and then falls back in rain. Further why the water springs from the summits of the mountains, and whether any spring of water higher than the ocean can pour forth water higher than the surface of this ocean; and how all the water that returns to the ocean is higher than the sphere of the water: and how the water of the equinoctial seas is higher than the northern waters, and is higher beneath the body of the sun than in any other part of the circle of the equator; for when the experiment is made under the heat of a burning brand, the water boils as the effect of the brand, and the water around the centre of where it boils descends in a circular wave. And how the waters of the north are lower than the other seas, and more so as they become colder, until they are changed into ice. (*E* 12 *r.*)

THE BEGINNING OF THE TREATISE ON WATER

Man has been called by the ancients a lesser world, and indeed the term is rightly applied, seeing that if man is compounded of earth, water, air and fire, this body of the earth is the same; and as man has within himself bones as a stay and framework for the flesh, so the world has the rocks which are the supports of the

earth; as man has within him a pool of blood wherein the lungs as he breathes expand and contract, so the body of the earth has its ocean, which also rises and falls every six hours with the breathing of the world; as from the said pool of blood proceed the veins which spread out their branches throughout the human body, in just the same manner the ocean fills the body of the earth with an infinite number of veins of water. In this body of the earth there is lacking, however, the sinews, and these are absent because sinews are created for the purpose of movement, and as the world is perpetually stable within itself no movement ever takes place there, and in the absence of any movement the sinews are not necessary; but in all other things man and the world show a great resemblance. (*A* 55 *v.*)

OF THE HEAT THAT IS IN THE WORLD

Where there is life there is heat, and where there is vital heat there is movement of vapour. This is proved because one sees that the heat of the element of fire always draws to itself the damp vapours, the thick mists and dense clouds which are given off by the seas and other lakes and rivers and marshy valleys. And drawing these little by little up to the cold region, there the first part halts, because the warm and moist cannot exist with cold and dryness; and this first part having halted receives the other parts, and so all the parts joining together one to another form thick and dark clouds. And these are often swept away and carried by the winds from one region to another, until at last their density gives them

such weight that they fall in thick rain; but if the heat of the sun is added to the power of the element of fire, the clouds are drawn up higher, and come to more intense cold, and there become frozen, and so produce hailstorms.

So the same heat which holds up so great a weight of water as is seen to fall in rain from the clouds, sucks it up from below from the roots of the mountains and draws it up and confines it among the mountain summits, and there the water finds crevices, and so continuing it issues forth and creates rivers. (*A* 55 *v.*)

OF THE SEA WHICH GIRDLES THE EARTH

I perceive that the surface of the earth was from of old entirely filled up and covered over in its level plains by the salt waters, and that the mountains, the bones of the earth, with their wide bases, penetrated and towered up amid the air, covered over and clad with much high-lying soil. Subsequently, the incessant rains have caused the rivers to increase, and by repeated washing, have stripped bare part of the lofty summits of these mountains, leaving the site of the earth, so that the rock finds itself exposed to the air, and the earth has departed from these places. And the earth from off the slopes and the lofty summits of the mountains has already descended to their bases, and has raised the floors of the seas which encircle these bases, and caused the plain to be uncovered, and in some parts has driven away the seas from there over a great distance. (*C. A.* 126 *v. b.*)

OF THE FOAM OF WATER

Water which falls from a height into other water imprisons within itself a certain quantity of air, and this through the force of the blow becomes submerged with it, and then with swift movement rises up again and arrives at the surface which it has quitted, clothed with a fine veil of moisture, spherical in form, and proceeds by circles away from the spot where it first struck. Or the water which falls down upon other water runs away from the spot where it strikes, in various different branches, bifurcating and mingling and interlacing one with another; and some, being hollow, are dashed back upon the surface of the water; and so great is the force of the weight, and of the shock caused by this water, that through its extreme swiftness the air is unable to escape into its own element, but on the contrary is submerged in the manner that I have stated above. (*A* 59 *r.*)

OF THE OPINION HELD BY SOME THAT THE WATER OF SOME SEAS IS HIGHER THAN THE HIGHEST SUMMITS OF THE MOUNTAINS AND THAT THE WATER WAS DRIVEN UP TO THESE SUMMITS

Water will not move from one spot to another unless to seek a lower level, and in the natural course of its current it will never be able to return to an elevation equal to that of the spot where it first issued forth from the mountains and came into the light. That part of the sea which by an error of imagination you state to have been so high as to have flowed over the summits of

the high mountains for so many centuries, would be consumed and poured out in the water that has issued from these same mountains. You can well imagine that during all the time that the Tigris and the Euphrates have flowed from the summits of the Armenian mountains,[1] one may suppose the whole of the water of the ocean to have passed a great many times through their mouths. Or do you not believe that the Nile has discharged more water into the sea than is at present contained in all the watery element? Surely this is the case! If then this water had fallen away from this body of the earth, the whole mechanism would long since have been without water. So, therefore, one may conclude that the water passes from the rivers to the sea, and from the sea to the rivers, ever making the self-same round, and that all the sea and the rivers have passed through the mouth of the Nile an infinite number of times.

(*A* 56 *r. and v.*)

WHAT CAUSES THE EDDIES OF WATER

All the movements of the wind resemble those of the water.

Universally all things desire to maintain themselves in their natural state. So moving water strives to maintain the course pursuant to the power which occasions it, and if it finds an obstacle in its path, it completes the span of the course it has commenced by a circular and revolving movement.

So when water pours out of a narrow channel and descends with fury into the slow-moving currents of

[1] Text is not 'de monti eruini' as in M. Ravaisson-Mollien's transcript, but 'de mōti ermjnj' (de monti ermini) as given by Dr. Richter.

mighty seas, since in the greater bulk there is greater power, and greater power offers resistance to the lesser, in this case, the water descending upon the sea beats down upon its slow-moving mass, and this cannot make a place for it with sufficient speed, because it is held up by the rest of the water; and so the water that descends, not being willing to slacken its course, turns round after it has struck, and continues its first movement in circling eddies, and so fulfils its desire down in the depth; for in these same eddies it finds nothing more than its own movement, which is attended by a succession of circles, one within the other; and by thus revolving in circles, its course becomes longer and more continuous, because it meets with no obstacle except itself; and this motion eats away and consumes the banks, and they fall headlong in ruin. . . . (*A* 60 *r.*)

OF WAVES

The wave is the recoil of the stroke, and it will be greater or less in proportion as the stroke itself is greater or less. A wave is never found alone, but is mingled with as many other waves as there are uneven places in the object where the said wave is produced. At one and the same time there will be moving over the greatest wave of a sea innumerable other waves proceeding in different directions. If you throw a stone into a sea with various shores, all the waves which strike against these shores are thrown back towards where the stone has struck, and on meeting others advancing, they never interrupt each other's course. Waves of equal volume, velocity, and power, when they encounter each other in opposing

motion, recoil at equal angles, the one from the stroke of the other. That wave will be of greater elevation which is created by the greater stroke, and the same is true of the converse. The wave produced in small tracts of water will go and return many times from the spot which has been struck. The wave goes and returns so many more times in proportion as the sea which produces it contains a less quantity of water, and so conversely. Only on the high sea do the waves advance without ever turning in recoil. In lesser tracts of water the same stroke gives birth to many motions of advance and recoil. The greatest wave is covered with innumerable other waves moving in different directions; and these have a greater or less depth as they are occasioned by a greater or less power. The greatest wave is covered with various waves, which move in as many different directions as there were different places from which they separated themselves. The same wave produced within a small tract of water has a greater number of other waves proceeding over itself, in proportion to the greater strength of its stroke and recoil from the opposite shores. Greater is the motion of the wave than that of the water of which it is composed. Many waves turned in different directions can be created between the surface and the bottom of the same body of water at the same time. The eddying movements can accompany the direct movements of each wave.

All the impressions caused by things striking upon the water can penetrate one another without being destroyed. One wave never penetrates another; but they only recoil from the spot where they strike.

(*C. A.* 84 *v. a.*)

INSTANCES AND DEDUCTIONS AS TO THE EARTH'S INCREASE

Take a vase, fill it full of pure earth, and set it up on a roof. You will see how immediately the green herbs will begin to shoot up, and how these, when fully grown, will cast their various seeds; and after the children have thus fallen at the feet of their parents, you will see the herbs, having cast their seeds, becoming withered and falling back again to the earth, and within a short time becoming changed into the earth's substance and giving it increase; after this you will see the seeds springing up and passing through the same course, and so you will always see the successive generations after completing their natural course, by their death and corruption giving increase to the earth. And if you let ten years elapse and then measure the increase in the soil, you will be able to discover how much the earth in general has increased, and then by multiplying you will see how great has been the increase of the earth in the world during a thousand years. Some may say that this instance of the vase which I have mentioned does not justify the deduction based upon it, because one sees in the case of these vases, that for the prize of the flowers that are looked for, a part of the soil is frequently taken away, and its place is filled up with new rich soil; and I reply to them that as the soil which is added there is a blend of rich fat substances and broken bits of all sorts of things, it cannot be said to be pure earth, and this mass of substances, decaying, and so losing in part their shape, becomes changed into a rich ooze, which feeds the roots of the

plants above them ; and this is the reason why it may appear to you that the earth is lessened ; but if you allow the plants that grow in it to die, and their seeds to spring up, then in time you will behold its increase.

For do you not perceive how, among the high mountains, the walls of ancient and ruined cities are being covered over and concealed by the earth's increase ?

Nay, have you not seen how, on the rocky summits of the mountains, the live stone itself has in course of time swallowed up by its growth some column which it supported, and stripping it bare as with shears, and grasping it tightly, has left the impress of its fluted form in the living rock ? (*C. A.* 265 *r. a.*)

The water wears away the mountains and fills up the valleys, and if it had the power, it would reduce the earth to a perfect sphere. (*C. A.* 185 *v. c.*)

If a drop of water falls into the sea when it is calm, it must of necessity be that the whole surface of the sea is raised imperceptibly, seeing that water cannot be compressed within itself, like air. (*C. A.* 20 *r. a.*)

WHY WATER IS SALT

Pliny says in his second book, in the hundred and third chapter, that the water of the sea is salt because the heat of the sun scorches and dries up the moisture and sucks it up and thereby greatly increases the salt savour of the sea.

But this cannot be admitted because, if the saltness

of the sea were caused by the heat of the sun, there is no doubt that the lakes and pools and marshes would be more salt in proportion as their waters have less movement and depth, but on the contrary experience shows us that the waters of these marshes are entirely free from saltness. It is also stated by Pliny, in the same chapter, that this saltness might arise because, after the subtraction of every sweet and tenuous portion such as the heat readily draws to itself, the more bitter and coarser portion will be left behind, and in consequence the water on the surface is sweeter than that at the bottom. But this is contradicted by the reasons given above, whence it follows that the same thing would happen with marshes and other tracts of water which become dried up by the heat. It has also been said that the saltness of the sea is the sweat of the earth, but to this we may reply that then all the springs of water which penetrate through the earth would be salt. The conclusion, therefore, is that the saltness of the sea is due to the numerous springs of water, which, in penetrating the earth, find the salt mines, and dissolving parts of these carry them away with them to the ocean and to the other seas, from whence they are never lifted by the clouds which produce the rivers. So the sea would be more salt in our times than it has ever been at any time previously; and if it were argued by the adversary that in an infinite course of time the sea would either become dried up or congealed into salt, to this I reply that the salt is restored to the earth by the setting free of the earth which is raised up together with the salt it has acquired, and the rivers restore it to the earth over which they flow. (G 48 v.)

If a stone is thrown into still water it will form circles equidistant from their centre ; but if into a moving river the circles formed will lengthen out and be almost oval in shape, and will travel on together with their centre away from the spot where it was first made, following the course of the [stream] . . . (*I* 87 [39] *r.*)

Water will leap up far higher than it has fallen, through the violent movement caused by the air which finds itself shut in within the bubbles of the water, and which afterwards rises and floats like bells upon the surface of the water. Returning to the place where it strikes, the water is again submerged by the blow, so that the air finds itself hemmed in between the water which drives it down and that which encounters it, and being pressed upon with such fury and violence, suddenly bursts through the water which serves it as a covering, and, like a thunderbolt emerging from the clouds, so this air emerges from the water, carrying with it a part of the water[1] which previously formed its covering. (*I* 69 [21] *v.*)

THE DESTRUCTION OF MARSHES WILL BE BROUGHT ABOUT WHEN TURBID RIVERS FLOW INTO THEM

This is proved by the fact that where the river flows swiftly it washes away the soil, and where it delays there it leaves its deposit, and both for this reason, and because water never travels so slowly in rivers as it does in the marshes of the valleys, the movement of the waters there is imperceptible. But in these marshes the river has to enter through a low, narrow, winding channel, and it has

[1] MS. has 'aria,' air.

to flow out over a large area of but little depth; and this is necessary because the water flowing in the river is thicker and more laden with earth in the lower than in the upper part; and the sluggish water of the marshes also is the same, but the variation between the lightness and heaviness of the upper and lower waters of the marshes far exceeds that in the currents of rivers, in which the lightness of the upper part differs but little from the heaviness of the part below.

So the conclusion is that the marsh will be destroyed because it is receiving turbid water below, while above, on the opposite side of the same marsh, only clear water is flowing out; and, consequently, the bed of the marsh will of necessity be raised by means of the soil which is being continually discharged into it. (*E* 5 *r.*)

OF HOW THE SEA CHANGES THE WEIGHT OF THE EARTH

The shells of oysters and other similar creatures which are born in the mud of the sea, testify to us of the change in the earth round the centre of our elements. This is proved as follows:—the mighty rivers always flow turbid because of the earth stirred up in them through the friction of their waters upon their bed and against the banks; and this process of destruction uncovers the tops of the ridges formed by the layers of these shells, which are embedded in the mud of the sea where they were born when the salt waters covered them. And these same ridges were from time to time covered over by varying thicknesses of mud which had

been brought down to the sea by the rivers in floods of varying magnitude ; and in this way these shells remained walled up and dead beneath this mud, which became raised to such a height that the bed of the sea emerged into the air. And now these beds are of so great a height that they have become hills or lofty mountains, and the rivers, which wear away the sides of these mountains, lay bare the strata of the shells, and so the light surface of the earth is continually raised, and the antipodes draw nearer to the centre of the earth, and the ancient beds of the sea become chains of mountains. (*E* 4 *v.*)

DOUBT

Here a doubt arises, and that is as to whether the Flood which came in the time of Noah was universal or not, and this would seem not to have been the case for the reasons which will now be given. We have it in the Bible that the said Flood was caused by forty days and forty nights of continuous and universal rain, and that this rain rose ten cubits above the highest mountain in the world. But, consequently, if it had been the case that the rain was universal, it would have formed in itself a covering around our globe which is spherical in shape ; and a sphere has every part of its circumference equally distant from its centre, and therefore, on the sphere of water finding itself in the aforesaid condition, it becomes impossible for the water on its surface to move, since water does not move of its own accord unless to descend. How then did the waters of so great a Flood depart if it is proved that they had no power

of motion? If it departed, how did it move, unless it went upwards? At this point natural causes fail us, and therefore in order to resolve such a doubt we must needs either call in a miracle to our aid or else say that all this water was evaporated by the heat of the sun.

(*C. A.* 155 *r. b.*)

OF THE FLOOD AND OF MARINE SHELLS

If you should say that the shells which are visible at the present time within the borders of Italy, far away from the sea and at great heights, are due to the Flood having deposited them there, I reply that, granting this Flood to have risen seven cubits above the highest mountain, as he has written who measured it, these shells which always inhabit near the shores of the sea ought to be found lying on the mountain sides, and not at so short a distance above their bases, and all at the same level, layer upon layer.

Should you say that the nature of these shells is to keep near the edge of the sea, and that as the sea rose in height the shells left their former place and followed the rising waters up to their highest level:—to this I reply that the cockle is a creature incapable of more rapid movement than the snail out of water, or is even somewhat slower, since it does not swim, but makes a furrow in the sand, and supporting itself by means of the sides of this furrow it will travel between three and four braccia in a day; and therefore with such a motion as this it could not have travelled from the Adriatic sea as far as Monferrato in Lombardy, a distance of two

hundred and fifty miles in forty days,—as he has said who kept a record of that time.

And if you say that the waves carried them there—they could not move by reason of their weight except upon their base. And if you do not grant me this, at any rate allow that they must have remained on the tops of the highest mountains, and in the lakes which are shut in among the mountains, such as the lake of Lario or Como, and Lake Maggiore, and that of Fiesole and of Perugia and others.

If you should say that the shells were empty and dead when carried by the waves, I reply that where the dead ones went the living were not far distant, and in these mountains are found all living ones, for they are known by the shells being in pairs and by their being in a row without any dead, and a little higher up is the place where all the dead with their shells separated have been cast up by the waves, near where the rivers plunged in mighty chasm into the sea. So it was with the Arno, which fell from the Gonfolina near to Monte Lupo and there left gravel deposits, which deposits are still to be seen welded together and forming one concrete mass of various kinds of stones from different localities and of varying colour and hardness. And a little further on, where the river turns towards Castel Fiorentino, the hardening of the sand has formed tufa stone; and below this it has deposited the mud in which the shells lived; and the mud has risen by degrees as the floods of the Arno poured their turbid waters into this sea. So from time to time the floor of the sea was raised, and this caused these shells to be in layers.

This is seen in the cutting of Colle Gonzoli, which has been made precipitous by the action of the Arno wearing away its base, in which cutting the aforesaid layers of shells are plainly to be seen in the bluish clay, and there are also to be found other things from the sea.

(*Leic.* 8 *b* [*R* 987])

As for those who say that the shells are found over a wide area and produced at a distance from the sea by the nature of the locality and the disposition of the heavens which moves and influences the place to such a creation of animal life,—to them it may be answered that, granted such an influence over these animals, they could not happen all in one line, save in the case of those of the same species and age; and not one old and another young, one with an outer covering and another without, one broken and another whole, nor one filled with sea sand, and the fragments great and small of others inside the whole shells which stand gaping open; nor the claws of crabs without the rest of their bodies; nor with the shells of other species fastened on to them, like animals crawling over them and leaving the mark of their track on the outside where it has eaten its way like a worm in wood; nor would there be found among them bones and teeth of fish which some call arrows, others serpents' tongues; nor would so many parts of different animals be found joined together, unless they had been thrown up there upon the borders of the sea.

And the Flood could not have carried them there, because things which are heavier than water do not float high in the water, and the aforesaid things could not be

at such heights unless they had been carried there floating on the waves, and that is impossible on account of their weight.

Where the valleys have never been covered by the salt waters of the sea, there the shells are never found.

(*Leic.* 9 *a* [*R* 988])

Since things are far more ancient than letters, it is not to be wondered at if in our days there exists no record of how the aforesaid seas extended over so many countries; and if moreover such record ever existed, the wars, the conflagrations, the deluges of the waters, the changes in speech and habits have destroyed every vestige of the past. But sufficient for us is the testimony of things produced in the salt waters and now found again in the high mountains far from the seas.

(*Leic.* 31 *a* [*R* 984])

OF THE BONES OF FISHES FOUND IN THOSE THAT HAVE BEEN PETRIFIED

All the creatures that have their bones within their skin, on being covered over by the mud from the inundations of rivers which have left their accustomed beds, are at once enclosed in a mould by this mud. And so in course of time as the channels of the rivers become lower, these creatures being embedded and shut in within the mud, and the flesh and organs being worn away and only the bones remaining, while even these have lost their natural order of arrangement, they have fallen down into the base of the mould which has been formed by their impress; and as the mud becomes lifted above the level of the stream, the water runs away so that it

dries and becomes first a sticky paste and then changes into stone, enclosing whatsoever it finds within itself, and itself filling up every cavity; and finding the hollow part of the mould formed by these creatures, it percolates gradually through the tiny crevices in the earth through which the air that is within escapes away, that is laterally, for it cannot escape upwards since there the crevices are filled up by the moisture descending into the cavity, nor can it escape downwards because the moisture which has already fallen has closed up the crevices. There remain the openings at the side, whence this air, condensed and pressed down upon by the moisture which descends, escapes with the same slow rate of progress as that of the moisture which descends there; and this paste as it dries becomes stone which is devoid of weight, and preserves the exact shapes of the creatures which have there made the mould, and encloses their bones within it. (*F* 79 *v.*)

SHELLS AND THE REASON OF THEIR SHAPE

The creature that resides within the shell constructs its dwelling with joints and seams and roofing and the other various parts, just as man does in the house in which he dwells; and this creature expands the house and roof gradually in proportion as its body increases and as it is attached to the sides of these shells. Consequently the brightness and smoothness which these shells possess on the inner side is somewhat dulled at the point where they are attached to the creature that dwells there, and the hollow of it is roughened, ready to receive the

knitting together of the muscles by means of which the creature draws itself in when it wishes to shut itself up within its house.

When nature is on the point of creating stones, it produces a kind of sticky paste, which, as it dries, forms itself into a solid mass together with whatever it has enclosed there, which, however, it does not change into stone but preserves within itself in the form in which it has found them. This is why leaves are found whole within the rocks which are formed at the bases of the mountains, together with a mixture of different kinds of things, just as they have been left there by the floods from the rivers which have occurred in the autumn seasons; and there the mud caused by the successive inundations has covered them over, and then this mud grows into one mass together with the aforesaid paste, and becomes changed into successive layers of stone which correspond with the layers of the mud. (*F* 80 *r.*)

OF CREATURES WHICH HAVE THEIR BONES ON THE OUTSIDE, LIKE COCKLES, SNAILS, OYSTERS, SCOLLOPS, 'BOUOLI' AND THE LIKE, WHICH ARE OF INNUMERABLE KINDS

When the floods of the rivers which were turbid with fine mud deposited this upon the creatures which dwelt beneath the waters near the ocean borders, these creatures became embedded in this mud, and finding themselves entirely covered under a great weight of mud they were forced to perish for lack of a supply of the creatures on which they were accustomed to feed.

In course of time the level of the sea became lower, and as the salt water flowed away this mud became changed into stone; and such of these shells as had lost their inhabitants became filled up in their stead with mud; and consequently, during the process of change of all the surrounding mud into stone, this mud also which was within the frames of the half-opened shells, since by the opening of the shell it was joined to the rest of the mud, became also itself changed into stone; and therefore all the frames of these shells were left between two petrified substances, namely that which surrounded them and that which they enclosed.

These are still to be found in many places, and almost all the petrified shell fish in the rocks of the mountains still have their natural frame round them, and especially those which were of a sufficient age to be preserved by reason of their hardness, while the younger ones which were already in great part changed into chalk were penetrated by the viscous and petrifying moisture.

(*F* 79 *r.*)

OF SHELLS IN MOUNTAINS

And if you wish to say that the shells are produced by nature in these mountains by means of the influence of the stars, in what way will you show that this influence produces in the very same place shells of various sizes and varying in age, and of different kinds?

SHINGLE

And how will you explain to me the fact of the shingle being all stuck together and lying in layers at different

altitudes upon the high mountains? For there there is to be found shingle from divers parts carried from various countries to the same spot by the rivers in their course; and this shingle is nothing but pieces of stone which have lost their sharp edges from having been rolled over and over for a long time, and from the various blows and falls which they have met with during the passage of the waters which have brought them to this spot.

LEAVES

And how will you account for the very great number of different kinds of leaves embedded in the high rocks of these mountains, and for the *aliga*, the seaweed, which is found lying intermingled with the shells and the sand? And in the same way you will see all kinds of petrified things together with ocean crabs broken in pieces and separated, and mixed with their shells. (*F* 80 *v.*)

WHAT IS FORCE?

Force I define as an incorporeal agency, an invisible power, which by means of unforeseen external pressure is caused by the movement stored up and diffused within bodies which are withheld and turned aside from their natural uses; imparting to these an active life of marvellous power, it constrains all created things to change of form and position, and hastens furiously to its desired death, changing as it goes according to circumstances. When it is slow its strength is increased, and speed enfeebles it. It is born in violence and dies in liberty; and the greater it is the more quickly it is consumed. It drives away in fury whatever opposes its destruction.

It desires to conquer and slay the cause of opposition, and in conquering destroys itself. It waxes more powerful where it finds the greater obstacle. Everything instinctively flees from death. Everything when under constraint itself constrains other things. Without force nothing moves. The body in which it is born neither grows in weight nor in form. None of the movements that it makes are lasting. It increases by effort and disappears when at rest. The body within which it is confined is deprived of liberty. Often also by its movement it generates new force. (*A* 34 *v.*)

OF WHAT FORCE IS

Force I define as a spiritual power, incorporeal and invisible, which with brief life is produced in those bodies which as the result of accidental violence are brought out of their natural state and condition.

I have said spiritual because in this force there is an active, incorporeal life; and I call it invisible because the body in which it is created does not increase either in weight or in size; and of brief duration because it desires perpetually to subdue its cause, and when this is subdued it kills itself. (*B* 63 *r.*)

AGAINST PERPETUAL MOTION

No inanimate object will move of its own accord; consequently when in motion it will be moved by unequal power, unequal that is in time and velocity, or unequal in weight; and when the impulse of the first motive power ceases the second will cease abruptly. (*A* 22 *v.*)

Every impression is preserved for a time in its sensi-

tive object; and that which was of greater power will be preserved in its object for a longer time, and for a shorter time with the less powerful. In this connection I apply the term sensitive to such object as by any impression is changed from that which was at first an insensible object;—that is one which, while changing from its first state, preserves within itself no impression of the thing which has moved it. The sensible impression is that of a blow received upon a resounding substance, such as bells and such like things, or like the note in the ear, which, indeed, unless it preserved the impression of the notes, could never derive pleasure from hearing a voice alone; for when it passes immediately from the first to the fifth note, the effect is as though one heard these two notes at the same time, and thus perceived the true harmony which the first makes with the fifth; but if the impression of the first note did not remain in the ear for an appreciable space of time, the fifth, which follows immediately after the first, would seem alone, and one note cannot create any harmony, and consequently any song whatsoever occurring alone would seem to be devoid of charm.

So, too, the radiance of the sun or other luminous body remains in the eye for some time after it has been seen; and the motion of a single firebrand whirled rapidly in a circle causes this circle to seem one continuous and uniform flame.

The drops of rain water seem continuous threads descending from their clouds; and so herein one may see how the eye preserves the impressions of the moving things which it sees.

The insensible objects which do not preserve the impressions of the things which are opposite to them are mirrors, and any polished substance which, so soon as ever the thing of which it bears the impression is removed from before it, becomes at once entirely deprived of that impression. We may, therefore, conclude that it is the action of the mover pressing against the body moved by it which moves this body in the direction in which it moves.

Amongst the cases of impressions being preserved in various bodies we may also instance the wave, the eddies of the water, the winds in the air, and a knife stuck into a table, which, on being bent in one direction and then released, retains for a long time a quivering movement, all its movements being reciprocal one of another, and all may be said to be approaching towards the perpendicular of the surface where the knife is fixed by its point.

The voice impresses itself through the air without displacement of air, and strikes upon the objects and returns back to its source.

The concussion of liquid bodies with solid is of a different character to the above-mentioned cases of concussion; and the concussion of liquid with liquid also varies from the foregoing.

Of the concussion of solid with liquid there is seen an example in the shores of the ocean, which receive the waters full on their rocks and hurl them against the steep crags; and oftentimes it happens that before the course of the wave is half completed, the stones carried by it return to the sea from whence they came; and their

power of destruction is increased by the might of the wave which falls back from the lofty cliffs.

(*C. A.* 360 *r. a.*)

Seeing that the images of the objects are all spread throughout all the air which surrounds them, and are all in every point of the same, it must be that the images of our hemisphere enter and pass together with those of all the heavenly bodies through the natural point, in which they merge and become united by mutually penetrating and intersecting each other, whereby the image of the moon in the east and the image of the sun in the west at this natural point become united and blended together with our hemisphere.

O marvellous Necessity, thou with supreme reason constrainest all effects to be the direct result of their causes, and by a supreme and irrevocable law every natural action obeys thee by the shortest possible process!

Who would believe that so small a space could contain the images of all the universe? O mighty process! What talent can avail to penetrate a nature such as thine? What tongue will it be that can unfold so great a wonder? Verily, none! This it is that guides the human discourse to the considering of divine things.

Here the figures, here the colours, here all the images of every part of the universe are contracted to a point.

O what point is so marvellous!

O wonderful, O stupendous Necessity, thou by thy law constrainest all effects to issue from their causes in

the briefest possible way! These are the miracles, . . . forms already lost, mingled together in so small a space, it can recreate and reconstitute by its dilation.

How it may be that from indistinct causes there may issue effects manifest and immediate, as are the images which have passed through the aforesaid natural point.

Write in thy Anatomy what proportion there is between the diameters of all the lenses of the eye, and the distance from these to the crystalline lens.

(*C. A.* 345 *v. b.*)

OF THE NATURE OF SIGHT

I say that sight is exercised by all animals through the medium of light; and if against this any one should instance the sight of nocturnal animals, I would say that these in exactly the same way are subject to the same law of nature. For, as one may readily understand, the senses, when they receive the images of things, do not send forth from themselves any actual power; but on the contrary the air which is between the object and the sense, serving as a medium, incorporates within itself the images of things, and by its own contact with the sense presents them to it, if the objects either by sound or smell project themselves to the eye or the nose by virtue of their incorporeal powers. Here the light is not necessary, nor is it made use of. The forms of objects do not enter into the air as images unless they are luminous; this being so, the eye cannot receive the same from that air which does not contain them, but only

touches their surface. If you wish to speak of the many animals which hunt their prey by night, I answer that when that small amount of light sufficient for them to see their way fails them, they avail themselves of their powers of hearing and smell, which are not impeded by the darkness, and in which they are far in advance of man. If you watch a cat in the day-time leaping among a lot of pieces of crockery you will see that these will remain whole; but if it does the same by night it will break a considerable number. Night birds do not fly unless the moon is shining either full or in part, but their time of feeding is between the hour of sunset and the total darkness of the night.

No substance can be comprehended without light and shade; light and shade are caused by light.

(*C. A.* 90 *r. b.*)

OF THE EYE

Since the eye is the window of the soul, the latter is always in fear of being deprived of it, to such an extent that when anything moves in front of it which causes a man sudden fear, he does not use his hands to protect his heart, which supplies life to the head where dwells the lord of the senses, nor his hearing, nor sense of smell or taste; but immediately the affrighted sense, not contented with shutting the eyes and pressing their lids together with the utmost force, causes him to turn suddenly in the opposite direction; and not as yet feeling secure he covers them with the one hand and stretches out the other to form a screen against the object of his fear. (*C. A.* 119 *v. a.*)

The eye, which is used to the darkness, on suddenly beholding the light is hurt and therefore closes quickly, being unable to endure the light. This is due to the fact that the pupil in order to recognise any object in the darkness to which it has grown accustomed, increases in size, employing all its force to transmit to the receptive part the image of things in shadow. And the light, suddenly penetrating, causes too large a part of the pupil which was in darkness to be hurt by the radiance which bursts in upon it, this being the exact opposite of the darkness to which the eye has already grown accustomed and habituated, and which seeks to maintain itself there, and will not quit its hold without inflicting injury upon the eye.

One might also say that the pain caused to the eye when in shadow by the sudden light arises from the sudden contraction of the pupil, which does not occur except as the result of the sudden contact and friction of the sensitive parts of the eye. If you would see an instance of this, observe and note carefully the size of the pupil when any one is looking at a dark place, and then cause a candle to be brought before it, and make it rapidly approach the eye, and you will see an instantaneous contraction of the pupil. (*C* 16 *r.*)

OF BODILY MOVEMENTS

I say that the note of the echo is cast back to the ear after it has struck, just as the images of objects strike the mirror and are thence reflected to the eye. And in the same way as these images fall from the object to the mirror and from the mirror to the eye at equal angles, so

the note of the echo will strike and rebound within the hollow where it has first struck at equal angles to the ear.
(*C* 16 *r.*)

If the darkness of the night is a hundred degrees more intense than that of the evening, and the eye of the man doubles the size of its pupil in the darkness, then the darkness is halved to the eye, since its power of vision has doubled the half; there remain, therefore, fifty degrees of intensity of darkness.

And if in the said darkness the eye of the owl expands its pupil a hundred times, the power of vision increases a hundred fold, so that a hundred degrees of power of vision are acquired; and since things which are the equal of each other do not exceed each other, the bird sees in the darkness with the pupil increased a hundred-fold just as in the day when the pupil is less by ninety-nine hundredths.

And if you should say that this creature cannot see light by day and for this reason remains in concealment, the answer to this is that the bird only conceals itself by day in order to escape from the crowd of the birds who are continually flocking round it in great numbers with a loud clamour, and very often they would lose their lives if they did not hide themselves in the grottoes and caverns of the high rocks.

Of the nocturnal animals only in the lion tribe does the pupil alter its shape as it grows larger or smaller; for when it is at the limit of its contraction it is long in form, when it is at the middle it is oval, and when it reaches its utmost expansion it is circular.
(*C. A.* 262 *r. d.*)

I say that the power of vision extends by means of the visual rays as far as the surface of bodies which are not transparent, and that the power possessed by these bodies extends up to the power of vision, and that every similar body fills all the surrounding air with its image. Each body separately and all together do the same, and not only do they fill it with the likeness of their shape, but also with that of their power.

EXAMPLE

You see with the sun when it is at the centre of our hemisphere, how there are the images of its form in all the parts where it reveals itself, and you see how in all those same places there are also the images of its radiance, and to these must also be added the image of the power of its heat; and all these powers proceed from the same source by means of radiant lines which issue from its body and end in the opaque objects without its thereby undergoing any diminution.

The north star remains continually with the images of its power spread out, and becoming incorporated not only in thin but in thick bodies, in those transparent and those opaque, but it does not on this account suffer any loss of its shape.

CONFUTATION

Those mathematicians, then, who say that the eye has no spiritual power which extends to a distance from itself, since, if it were so, it could not be without great diminution in the use of the power of vision, and that though the eye were as great as the body of the earth

it would of necessity be consumed in beholding the stars; and for this reason they maintain that the eye takes in but does not send forth anything from itself,—

EXAMPLE

What will these say of the musk which always keeps a great quantity of the atmosphere charged with its odour, and which, if it be carried a thousand miles, will permeate a thousand miles with that thickness of atmosphere without any diminution of itself?

Or will they say that the sound which the bell makes on its contact with the clapper, which daily of itself fills the whole countryside with its sound, must of necessity consume this bell?

Certainly, it seems to me, there are such men as these —and that is all that need be said of them.

EXAMPLES

Is not that snake called lamia seen daily by the rustics attracting to itself with fixed gaze, as the magnet attracts iron, the nightingale, which with mournful song hastens to her death?

It is said also that the wolf has power by its look to cause men to have hoarse voices.

The basilisk is said to have the power by its glance to deprive of life every living thing.

The ostrich and the spider are said to hatch their eggs by looking at them.

Maidens are said to have power in their eyes to attract to themselves the love of men.

The fish called *linno*, which some name after S. Ermo,

which is found off the coasts of Sardinia,—is it not seen at night by the fishermen shedding light with its eyes over a great quantity of water—as though they were two candles? And all those fishes, which come within the compass of this radiance, immediately come up to the surface of the water and turn over, dead. (*C. A.* 270 *v. c.*)

Landscapes are of a more beautiful azure when in fine weather the sun is at noon than at any other hour of the day, because the atmosphere is free from moisture; and viewing them under such conditions, you see the trees of a beautiful green at their extremities, and the shadows dark towards the centre; and in the further distance the atmosphere, which is interposed between you and them, appears more beautiful when beyond it there is some darker substance, and consequently the azure is most beautiful. Objects seen from that side on which the sun is shining will not display their shadows to you. But if you are lower than the sun, you will see what was not seen by the sun, and that will be all in shadow. The leaves of the trees which are between you and the sun are of two principal colours, namely, a most beautiful vivid green, and the reflection of the atmosphere, which illumines whatever is not visible to the sun, and the parts in shadow which only face the earth, and the darkest parts which are surrounded by something other than darkness. The trees by the countryside which are between you and the sun are far more beautiful than those in respect to which you are between the sun and them, and this is the case because those which are in the same direction as the sun show their leaves transparent

PLATE 5

LANDSCAPE WITH CLOUD EFFECT

Face p. 125

towards their extremities, and such as are not transparent, that is at the tips, reflect the light; and the shadows are dark because they are not covered by anything.

The trees, when you place yourself between them and the sun, will only display to you their light and natural colour, which is not of itself very conspicuous, and besides this, certain reflected lights, which, owing to their not being against a background that offers a strong contrast to their brightness, are but little in evidence; and if you are at a lower altitude than these, then those parts of them may be visible, on which the light of the sun does not fall, and these will be dark.

IN THE WIND

But if you are on the side from whence the wind is blowing, you will see the trees look much lighter than you would see them from the other sides, and this is due to the fact that the wind turns up the reverse side of the leaves, which is in all cases much paler than their right side; and especially will they be very light if the wind blows from the quarter where the sun happens to be, and if you have your back turned to it. (*B. M.* 263, *Ar.* 113 *v.*)

I have long had the opportunity of observing many different [atmospheric effects], and once, above Milan, over in the direction of Lake Maggiore, I saw a cloud shaped like a huge mountain made up of banks of fire, because the rays of the sun which was then setting red on the horizon had dyed it with their colour. This great cloud drew to itself all the little clouds which were round about it. And the great cloud remained stationary

and retained the light of the sun on its apex for an hour and a half after sunset, so enormous was its size. And about two hours after night had fallen there arose a stupendous and phenomenal wind storm.

(*Leic.* 28 *a* [*R* 1021.])

At the first hour of the day the atmosphere in the south near to the horizon has a dim haze of rose-flushed clouds; towards the west it grows darker, and towards the east the damp vapour of the horizon shows brighter than the actual horizon itself, and the white of the houses in the east is scarcely to be discerned, while in the south, the further distant they are, the more they assume a dark rose-flushed hue, and even more so in the west; and with the shadows it is the contrary, for these disappear before the white.

[. . .] in the east, and the tops of the trees are more visible than their bases, since the atmosphere is thicker lower down, and the structure becomes more indistinct at a height.

And in the south, the trees may scarcely be distinguished by reason of the vapour which darkens in the west and grows clear in the east. (*C. A.* 176 *r. b.*)

OF THE COLOUR OF THE ATMOSPHERE

I say that the blue which is seen in the atmosphere is not its own colour, but is caused by the heated moisture having evaporated into the most minute imperceptible particles, which the beams of the solar rays attract and cause to seem luminous against the deep intense darkness of the region of fire that forms a covering above them. And this may be seen, as I myself saw it, by

any one who ascends Monboso (Monte Rosa), a peak of the chain of Alps that divides France from Italy, at whose base spring the four rivers which flow as many different ways and water all Europe, and there is no other mountain that has its base at so great an elevation. This mountain towers to so great a height, as almost to pass above all the clouds ; and snow seldom falls there, but only hail in summer when the clouds are at their greatest height ; and there this hail accumulates, so that were it not for the infrequency[1] of the clouds thus rising and discharging themselves, which does not happen twice in an age, there would be an enormous mass of ice there, built up by the various layers of the hail ; and this I found very thick in the middle of July. And I saw the atmosphere dark overhead, and the rays of the sun striking the mountain had far more brightness than in the plains below, because less thickness of atmosphere lay between the summit of this mountain and the sun.

As a further example of the colour of the atmosphere, we may take the case of the smoke produced by old dry wood, for as it comes out of the chimneys it seems to be a pronounced blue when seen between the eye and a dark space, but as it rises higher and comes between the eye and the luminous atmosphere, it turns immediately to an ashen grey hue, and this comes to pass because it no longer has darkness beyond it, but in place of this the luminous atmosphere. But if this smoke comes from new green wood, then it will not assume a blue colour, because, as it is not transparent, and is heavily charged

[1] MS. has 'reta,' which Dr. Richter reads in sense of 'malanno.' I have adopted Dr. Solmi's suggestion 'rarità.'

with moisture, it will have the effect of a dense cloud which takes definite lights and shadows as though it were a solid body.

The same is true of the atmosphere, which excessive moisture renders white, while little moisture acted upon by heat causes it to be dark and of a dark blue colour; and this is sufficient as regards the definition of the colour of the atmosphere, although one may also say that if the atmosphere had this transparent blue as its natural colour, it would follow that wherever a greater quantity of atmosphere came between the eye and the fiery element, it would appear of a deeper shade of blue, as is seen with blue glass and with sapphires, which appear darker in proportion as they are thicker. The atmosphere, under these conditions, acts in exactly the opposite way, since where a greater quantity of it comes between the eye and the sphere of fire, there it is seen much whiter, and this happens towards the horizon; and in proportion as a lesser amount of atmosphere comes between the eye and the sphere of fire, of so much the deeper blue does it appear, even when we are in the low plains. It follows therefore, from what I say, that the atmosphere acquires its blueness from the particles of moisture which catch the luminous rays of the sun.

We may also observe the difference between the atoms of dust and those of the smoke seen in the sun's rays as they pass through the chinks of the walls in dark rooms, that the one seems the colour of ashes, and the other—the thin smoke—seems of a most beautiful blue. We may see also, in the dark shadows of mountains, far from the eye, that the atmosphere which is between the eye

and these shadows will appear very blue, and in the portion of these mountains which is in light, it will not vary much from its first colour.

But whoever would see a final proof, should stain a board with various different colours, among which he should include a very strong black, and then over them all he should lay a thin, transparent white, and he will then perceive that the lustre of the white will nowhere display a more beautiful blue than over the black,—but it must be very thin and finely ground.

(*Leic.* 4 *a* [*R* 300.])

When the smoke from dry wood comes between the eye of the observer and some dark space it appears blue. So the atmosphere appears blue because of the darkness which is beyond it; and if you look towards the horizon of the sky, you will see that the atmosphere is not blue, and this is due to its density; and so at every stage as you raise your eye up from this horizon to the sky which is above you, you will find that the atmosphere will seem darker, and this is because a lesser quantity of air interposes between your eye and this darkness. And if you are on the top of a high mountain the atmosphere will seem darker above you just in proportion as it becomes rarer between you and the said darkness; and this will be intensified at every successive stage of its height, so that at the last it will remain dark.

That smoke will appear the bluest which proceeds from the driest wood, and is nearest to the place of its origin, and when it is seen against the darkest background with the light of the sun upon it. (*F* 18 *r.*)

How at the mouths of certain valleys the gusts of wind strike down upon the waters and scoop them out in a great hollow, and carry the water up into the air in the shape of a column and of the colour of cloud. And this same thing I once saw taking place on a sand-bank in the Arno, where the sand was hollowed out to a depth of more than a man's stature, and the gravel of it was removed and whirled a great distance apart, and assumed in the air the form of a mighty campanile, and the summit of it grew like the branches of a great pine, and then it bent on meeting the swift wind which passed over the mountains. (*Leic.* 22 *b* [*R* 996.])

Though nature has given sensibility to pain to such living organisms as have the power of movement,—in order thereby to preserve the members which in this movement are liable to diminish and be destroyed,—the living organisms which have no power of movement do not have to encounter opposing objects, and plants consequently do not need to have a sensibility to pain, and so it comes about that if you break them they do not feel anguish in their members as do the animals.

(*H* 60 [12] *r.*)

Nothing grows in a spot where there is neither sentient, fibrous, or rational life. The feathers grow upon birds and change every year; hairs grow upon animals, and change every year except a part such as the hairs of the beard in lions and cats and creatures like these. The grass grows in the fields, the leaves upon the trees, and every year these are renewed in great

PLATE 6

MS. WITH TEXT OF 'PEL SITO DI VENERE' (FOR THE SHRINE OF VENUS), ALSO ARCHITECTURAL STUDIES AND SKETCH OF NEPTUNE WITH HIS HORSES

Face p. 131

part. So then we may say that the earth has a spirit of growth; that its flesh is the soil, its bones are the successive strata of the rocks which form the mountains, its muscles are the tufa stone, its blood the springs of its waters. The lake of blood that lies about the heart is the ocean; its breathing is by the increase and decrease of the blood in its pulses, and even so in the earth is the flow and ebb of the sea. And the heat of the spirit of the world is the fire which is spread throughout the earth; and the dwelling-place of its creative spirit is in the fires, which in divers parts of the earth are breathed out in baths and sulphur mines, and in volcanoes, such as Mount Aetna in Sicily, and many other places.

(*Leic.* 34 *a* [*R* 1000.])

FOR THE SHRINE OF VENUS

You should make steps on four sides by which to ascend to a plateau formed by nature on the summit of a rock; and let this rock be hollowed out, and supported with pillars in front, and pierced beneath by a great portico, wherein water should be falling into various basins of granite and porphyry and serpentine, within recesses shaped like a half-circle; and let the water in these be continually flowing over; and facing this portico towards the north, let there be a lake with a small island in the centre, and on this have a thick and shady wood. Let the waters at the top of the pillars be poured down into vases standing at their bases, and from these let there be flowing tiny rivulets.

From the coast.—Setting out from the coast of

Cilicia towards the south, you discover the beauty of the island of Cyprus, which . . .

(*Windsor MSS. Notes et dessins sur les Attitudes de l'Homme* [*Rouveyre*] 11 *r.*)

From the southern sea-board of Cilicia may be seen to the south the beautiful island of Cyprus, which was the realm of the goddess Venus ; and many there have been, who, impelled by her loveliness, have had their ships and rigging broken upon the rocks which lie amidst the seething waves. Here the beauty of some pleasant hill invites the wandering mariners to take their ease among its flowery verdure, where the zephyrs continually come and go, filling with sweet odours the island and the encompassing sea. Alas ! How many ships have foundered there ! How many vessels have been broken upon these rocks ! Here might be seen an innumerable host of ships ; some broken in pieces and half buried in sand ; here is visible the poop of one, and there a prow ; here a keel and there a rib ; and it seems like a day of judgment when there shall be a resurrection of dead ships, so great is the mass that covers the whole northern shore. There the northern winds resounding make strange and fearful noises.

(*Windsor MSS. Notes et dessins sur les Attitudes de l'Homme* [*Rouveyre*] 11 *v.*)

When mountains fall headlong over hollow places they shut in the air within their caverns, and this air, in order to escape, breaks through the earth, and so produces earthquakes.

My opponent says this cannot be the case, for either the whole mountain which covers the cavern falls or else only the inner part of it ; and if the whole falls, then the compressed air escapes through the opening of the cave which is uncovered, while if only the inner part falls then the compressed air escapes into the vacuum which is left by the falling earth. (*C. A.* 289 *v. b.*)

Amid all the causes of the destruction of human property, it seems to me that rivers on account of their excessive and violent inundations hold the foremost place. And if as against the fury of impetuous rivers any one should wish to uphold fire, such an one would seem to me to be lacking in judgment, for fire remains spent and dead when fuel fails it, but against the irreparable inundation caused by swollen and proud rivers no resource of human foresight can avail ; for in a succession of raging and seething [waves], gnawing and tearing away the high banks, growing turbid with the earth from the ploughed fields, destroying the houses therein and uprooting the tall trees it carries these as its prey down to the sea which is its lair, bearing along with it men, trees, animals, houses, and lands, sweeping away every dike and every kind of barrier, bearing with it the light things, and devastating and destroying those of weight, creating big landslips out of small fissures, filling up with its floods the low valleys, and rushing headlong with insistent and inexorable mass of waters.

What a need there is of flight for whoso is near ! O how many cities, how many lands, castles, villas and houses has it consumed !

How many of the labours of wretched husbandmen have been rendered idle and profitless! How many families has it brought to nought, and overwhelmed! What shall I say of the herds of cattle which have been drowned and lost!

And often issuing forth from its ancient rocky beds it washes over the tilled [lands]. . . .

(*C. A.* 361 *v. a.*)

Amid the whirling currents of the winds were seen a great number of companies of birds coming from distant lands, and these appeared in such a way as to be almost indistinguishable, for in their wheeling movements at one time all the birds of one company were seen edgewise, that is showing as little as possible of their bodies, and at another time showing the whole measure of their breadth, that is full in face; and at the time of their first appearance they took the form of an indistinguishable cloud, and then the second and third bands became by degrees more clearly defined as they approached nearer to the eye of the beholder.

And the nearest of the above-mentioned bands dropped down low with a slanting movement, and settled upon the dead bodies, which were borne along by the waves of this great deluge, and fed upon them, and so continued until such time as the buoyancy of the inflated dead bodies came to fail, and with slow descent they sank gradually down to the bottom of the waters.

(*C. A.* 354 *v. b.*)

Like an eddying wind scouring through a hollow,

sandy valley, and with speeding course driving into its vortex everything that opposes its furious onset. . . . Not otherwise does the northern blast drive back with its hurricane. . . . Nor does the tempestuous sea make so loud a roaring when the northern blast beats it back in foaming waves between Scylla and Charybdis, nor Stromboli nor Mount Etna when the pent-up, sulphurous fires, bursting open and rending asunder the mighty mountain by their force, are hurling through the air rocks and earth mingled together in the issuing belching flames. . . .

Nor when Etna's burning caverns vomit forth and give out again the uncontrollable element, and thrust it back to its own region in fury, driving before it whatever obstacle withstands its impetuous rage. . . .

And drawn on by my eager desire, anxious to behold the mighty . . . of the varied and strange forms created by the artificer nature, having wandered for some distance among the overhanging rocks, I came to the mouth of a huge cavern before which for a time I remained stupefied, not having been aware of its existence,—my back bent to an arch, my left hand clutching my knee, while with the right I made a shade for my lowered and contracted eyebrows ; bending continually first one way and then another in order to see whether I could discern anything inside, though this was rendered impossible by the intense darkness within ; and after remaining there for a time, suddenly there were awakened within me two emotions,—fear and desire,—fear of the dark, threatening cavern, desire to see whether there might be any marvellous thing therein. (*B. M.* 263, *Ar.* 155 *r.*)

O powerful and once living instrument of constructive nature, thy great strength not availing thee, thou must needs abandon thy tranquil life to obey the law which God and time ordained for all procreative nature! To thee availed not the branching, sturdy, dorsal fins wherewith pursuing thy prey thou wert wont to plough thy way, tempestuously tearing open the briny waves with thy breast.

O how many times the frightened shoals of dolphins and big tunny fish were seen to flee before thy insensate fury; and thou, lashing with swift, branching fins and forked tail, didst create in the sea mist and sudden tempest, with loud uproar and foundering of ships; with mighty wave thou didst heap up the open shores with the frightened and terrified fishes, which thus escaping from thee were left high and dry when the sea abandoned them, and became the plenteous and abundant spoil of the neighbouring peoples.

. . . . .

O time, swift despoiler of created things! How many kings, how many peoples hast thou brought low! How many changes of state and circumstance have followed since the wondrous form of this fish died here in this hollow, winding recess? Now destroyed by time patiently thou liest within this narrow space, and with thy bones despoiled and bare art become an armour and support to the mountain which lies above thee.[1]

(*B. M.* 263, *Ar.* 156 *r.*)

[1] The text of the above passage is in parts very indistinct. As my transcript differs in several places from that given by Dr. Richter (*Literary Works of L. da V.* § 1217), I give the passage *in extenso*:—

O potẽte e gia anjmato strumẽto dell arteficiosa natura | a tẽ nõ valẽdo le tue grã forze ti chõuene abãdonare la trãquilla vita obedjre alla legie | chel che djo el tẽpo dje alla gienjtrice natura a tette nõ ualse | le ramvte e (*Leg*)

O how many times hast thou been seen amid the waves of the mighty, swelling ocean, towering like a mountain, conquering and overcoming them! And with black finned back ploughing through the salt waves with proud and stately bearing! (*C. A.* 265 *r. a.*)

WHY NATURE DID NOT ORDAIN THAT ONE ANIMAL SHOULD NOT LIVE BY THE DEATH OF ANOTHER

Nature being capricious, and taking pleasure in creating and producing a succession of new lives and forms because she knows that they serve to increase her terrestrial substance, is more ready and swift so to create than time is to destroy; and therefore she has ordained that many of the animals shall serve as food one for the other. And as her desire is still unsatisfied, she frequently sends forth certain noisome and pestilential vapours upon the rapidly increasing herds of animals, and especially upon men, who increase very rapidly because other animals do

ha ghagliard(r)e (*apri*) schiene cholle quali tu seghuitādo la tua | pleda (*aprivis*) solchavi chopetto apredo chōtēpessta le salse ōde |

'O quāte volte (*'usti*) furono vedute le ɪpavrite schiere | de dalfini e de grā tonnj fugi(*d*)re dal inpia tua tua ffuria (*occhupare*) | ettu cho chol velocie ramvte lalie cholla forcielluta choda fuminādo gieneravj nel mare | nibia (*iatē pessta*) subita tēpessta chō grā busso e somersione dj navilj chō grā | de ōdamēto ēpievi gli schop(er)ti liti (*de grū*) degli ɪpavritj essbigho | ttitj pesscj e toglēdosi atte p(er) lasciato mare ri(*n*) masi in secchо djvenjvano sup(er)cha e a | bodante pleda de vicinj popolj.

'(*O tēpo quāti re.*)

'O tēpo chonsumatore delle (*dj tutte le*) chose : āteri volgiēdole | dai (*lo*) alle tratte viee nvuove e varie abitazionj (*O quāte* | *monarchie cha o quāti*). O tēpo (vɪcitore) velocie pledatore | della chleate chose quātj re quāti popolj ai tu djssfattj e quā | te mutazionj djsstatj e vari chasj (*so*) sono seghuitj po che la mara | vgliosa forma dj q(ue)sto pesscie quj morj | p(er) le chav(er)nose e ritorte interiora |

'ora disfato dal tēpo pazēte djaci j questo chivso locho chole jsspogliate spolpate e ignjvde ossa | ai fatto (*ra*) armadura e sosstegnjo al sop(r)a possto mōte.'

not feed upon them, and if these causes were removed the results would cease. So therefore this earth seeks to lose its life, desiring only constant reproduction, and as, for the reason which you have assigned and expounded, the effects are generally in harmony with their causes, so animals are a type of the life of the world.

(*B. M.* 263, *Ar.* 156 *v.*)

The watery element remained pent up within the raised banks of the rivers, and the sea is seen amid the upheaved masses of the earth; the surrounding air served to bind together and circumscribe the earth's manifold structure, because its mass which stood between the water and the fiery element remained straitly compassed about, and deprived of the needful supply of water. The rivers will remain without their waters; the fertile earth will put forth no more her light leaves, no more will the fields be decked with waving corn; all the animals will perish failing to find fresh grass for fodder, and the ravening lions and wolves and other beasts which live by prey will lack sustenance, and after many desperate shifts men will be forced to abandon their lives, and the human race will cease to be. Hence the fertile and fruitful earth being deserted will be left arid and sterile, but by reason of the stored-up moisture of the water confined within its depths and by the very activity of nature it will observe something of its law of growth, until after having passed through the cold and rarified air it will be forced to end its course in the element of fire; and then the surface of it will remain burnt to a cinder, and this will be the end of all terrestrial nature.

(*B. M.* 263, *Ar.* 155 *v.*)

Nothingness has no centre, and its boundaries are nothingness.

My opponent says that nothingness and a vacuum are one and the same thing, having indeed two separate names by which they are called, but not existing separately in nature.

The reply is that whenever there exists a vacuum there will also be the space which surrounds it, but nothingness exists apart from occupation of space ; it follows that nothingness and a vacuum are not the same, for the one is divisible to infinity, and nothingness cannot be divided because nothing can be less than it is ; and if you were to take part from it this part would be equal to the whole, and the whole to the part.

(*C. A.* 289 *v. b.*)

THE NOTE OF THE ECHO

The note of the echo is either continuous or intermittent, it occurs alone or is united, is of brief or long duration, finite or endless in sound, immediate or far away. It is continuous when the surface on which the echo is produced is uniformly concave. The note of the echo is intermittent when the place which produces it is broken and interrupted. It is alone when it is produced in one place only. It is united when it is produced in several places. It is either brief or long-continuing, as when it goes winding round within a bell which has been struck, or in a cistern or other hollow space, or in clouds wherein the note recurs at fixed distances in regular intervals of time, ever uniformly growing fainter,

and is like the wave that spreads itself out in a circle over the sea.

The sound often seems to proceed from the direction of the echo, and not from the place where the real sound is; and similarly it happened at Ghiera d'Adda, when a fire which broke out there caused in the air twelve lurid reflections upon twelve clouds, and the cause was not perceived. (*C. A.* 77 *v. b.*)

OF THE SOUND WHICH SEEMS TO REMAIN IN THE BELL AFTER THE STROKE

That sound which remains or seems to remain in the bell after it has received the stroke is not in the bell itself but in the ear of the listener, and the ear retains within itself the image of the stroke of the bell which it has heard, and only loses it by slow degrees, like that which the impression of the sun creates in the eye, which only by slow degrees becomes lost and is no longer seen.

A PROOF TO THE CONTRARY

If the aforesaid proposition were true, you would not be able to cause the sound of the bell to cease abruptly by touching it with the palm of the hand, especially at the beginning of its strength, for surely if it were touched it would not happen that as you touched the bell with the hand the ear would simultaneously withhold the sound; whereas we see that if after the stroke has taken place the hand is placed upon the thing which is struck the sound suddenly ceases. (*C. A.* 332 *v. a.*)

I have divided the *Treatise on Birds* into four books: of which the first treats of their flight by beating their wings; the second of flight without beating the wings and with the help of the wind; the third of flight in general, such as that of birds, bats, fishes, animals, and insects; the last of the mechanism of this movement. (*K* 3 *r.*)

I

The bird in its flight without the help of the wind drops half the wing downwards, and thrusts the other half towards the tip backwards; and the part which is moved down prevents the descent of the bird, and that which goes backwards drives the bird forward.

When the bird raises its wings it brings their extremities near together; and while lowering them it spreads them further apart during the first half of the movement, but after this middle stage as they continue to descend it brings them together again. (*K* 12 *v.*)

When the bird lowers one of its wings necessity constrains it instantly to extend it, for if it did not do so it would turn right over.

The bird when it wishes to turn does not beat its wings with equal movement, but moves the one which makes the convex of the circle it describes, more than that which makes the concave of the circle. (*K* 4 *v.*)

The bird beats its wings repeatedly on one side only when it wishes to turn round while one wing is held stationary; and this it does by taking a stroke with the wing in the direction of the tail, like a man rowing in

a boat with two oars, who takes many strokes on that side from which he wishes to escape, and keeps the other oar fixed. (*K* 7 *r.*)

Unless the movement of the wing which presses the air is swifter than the flight of the air when pressed, the air will not become condensed beneath the wing, and in consequence the bird will not support itself above the air.

That part of the air which is nearest to the wing will most resemble in its movement the movement of the wing which presses on it; and that part will be more stable which is further removed from the said wing.

That part of the air which is the nearest to the wing which presses on it, will have the greatest density.

The air has greater density when it is nearer to water, and [greater rarity] when it is nearer to the cold region, and midway between these it is purer.

The air of the cold region offers no resistance to the movement of the birds unless they have already passed through a considerable space of the air beneath them.

The extremities of the wings of birds are of necessity flexible.

The properties of the air are such that it may become condensed or rarefied. (*C. A.* 161 *r. a.*)

The birds which seek to penetrate within the approaching wind are in the habit of fluttering to the right and to the left, like sailors tacking against the direction of the winds; and this they do in order not to make a long descent, for if the bird did not guard against descending

for any great distance, it would be driven right against the current of the wind; and, entering under the wind slanting lengthwise, it will present so much of its weight by this line as to subdue the resistance of the wind.

(*K* 8 *v.*)

The opening and lowering of the tail and the spreading out of the wings at the same time to their full extent, arrests the swift movement of birds.

When birds in descending are near to the ground, and the head is below the tail, they then lower the tail, which is spread wide open, and take short strokes with the wings; and consequently the head becomes higher than the tail, and the speed is checked to such an extent that the bird alights on the ground without any shock.

In all the changes which birds make in their lines of movement they spread out their tails.

There are many birds which move their wings as swiftly when they raise them as when they let them fall: such as magpies and birds like these. (*L* 58 *v.*)

There are some birds which are in the habit of moving their wings more swiftly when they lower them than when they raise them, and this is seen to be the case with doves and such like birds.

There are others which lower their wings more slowly than they raise them, and this seen with rooks and other birds like these.

The birds which fly swiftly, keeping at the same distance above the ground, are in the habit of beating their wings downwards and behind them, downwards to the extent

necessary to prevent the bird from descending, and behind when they wish to advance with greater speed.

The speed of birds is checked by the opening and spreading out of the tail. (*L* 59 *v.*)

II

The imperceptible fluttering of the wings without any actual strokes keeps the bird poised and motionless amid the moving air.

The reverse movement against the direction of the wind will always be greater than the advancing movement; and the reverse movement when made with the course of the wind will be increased by the wind, and will become equal to the advancing movement.

The ways in which birds rise, without beating their wings but by circles, with the help of the wind, are of two kinds,—simple and complex. The simple comprise those in which, in their advancing movement, they travel above the flight of the wind, and at the end of it turn and face the direction of the wind, receiving its buffeting from beneath, and so finish the reverse movement against the wind.

The complex movement by which birds rise is also circular, and consists of an advancing and reverse movement against the direction of the wind in a course which takes the form of a half circle, and of an advancing and reverse movement which follows the course of the wind.

The simple circular movement of rising without beating the wings will always occur when there is great agitation of the winds, and this being the case, it follows that the bird in so rising is also carried a considerable

distance by the force of the wind. And the complex movement will be found to occur when there are light winds, for experience shows that in these complex movements the bird rises through the air without being carried too far by the wind in the direction in which it is travelling.

The down and feathers underneath the wings are plentiful, and at the ends of the wings and tail the tips of the feathers are flexible or capable of being bent, whilst those on the front of the wing, where it strikes the air, are firm. (*C. A.* 308 *r. b.*)

My opponent says that he cannot deny that the bird cannot fall either backwards or with head underneath in a perpendicular line; but that it seems to him that its descent may be sheer if it keeps the wings wide open and has one of the wings as well as the head below its centre of gravity.[1] To this argument the answer is the same as to what preceded it; that is, that if this bird being in such a position without having other means of aiding itself were to drop perpendicularly, it would be contrary to the fourth part of the second book of the Elements, where it was proved that every body which falls freely through the air will fall in such a way that the heaviest part of it will become the guide of its movement; and here the heaviest part is found to be midway between the extremities of the open wings, that is midway between the two lightest parts, and therefore, as has been proved, such a descent is impossible.

[1] The MS. has here an explanation of a diagram: 'that is, it will drop in the line *a b*, the wings *d c* being wide apart at their natural extension.'

We have therefore proved that when a bird has its wings spread out and its head somewhat raised, it is impossible for it ever to fall or descend in a perpendicular line ; on the contrary, it will always descend by a slanting line, and every tiny movement of wings or tail changes the direction and slanting descent of this line to the reflex movement

Nature has so provided that all the large birds can stay at so great an elevation that the wind which increases their flight may be of straight course and powerful. For if their flight were low, among mountains where the wind goes wandering and is perpetually full of eddies and whirlwinds, and where they cannot find any spot of shelter by reason of the fury of the icy blasts among the narrow defiles of the mountains, nor can so guide themselves with their great wings as to avoid being dashed upon the cliffs and the high rocks and trees, would not this sometimes prove to be the cause of their destruction ? Whereas at great altitudes whenever through some accident the course of the wind is changed in any way whatsoever the bird has always time to redirect its course, and in safety take a calm flight, which will always be entirely free ; and it can always pass above clouds and thereby avoid wetting its wings.

Inasmuch as all beginnings of things are often the cause of great results, so we may see a small almost imperceptible movement of the rudder to have power to turn a ship of marvellous size and loaded with a very heavy cargo, and that, too, amid such a weight of water as presses on its every beam, and in the teeth of the

impetuous winds which are enveloping its mighty sails. Therefore we may be certain in the case of those birds which can support themselves above the course of the winds without beating their wings, that a slight movement of wing or tail, which will serve them to enter either below or above the wind, will suffice to prevent the fall of the said birds. (*C. A.* 308 *v. b.*)

The helms which are on the shoulders of the wings are necessary when the bird in its flight without beating its wings wishes to maintain itself in part of a tract of air, upon which it is either slipping down or rising, and when it wishes to bend either upwards or downwards or to right or left. It then uses these helms in this manner: if the bird wishes to rise it spreads the helm in the opposite direction to the way the wind strikes it; and if to descend it spreads the top part of the helm slanting to the course of the wind. If it turns to the right it spreads the right helm to the wind, and if it turns to the left it spreads the left helm to the wind. (*K* 7 *v.*)

When the bird rises up by the assistance of the wind without beating its wings, it spreads out and raises its wings so that they form an arch with the concave side towards the sky, and it receives the wind under its wings continually, in its movement to and fro, and this would cause it to turn right over, if it were not that the point of its tail is turned to the wind as it enters beneath the wind; and this afterwards by its power of resistance acts to prevent the said movement of turning over, because the wings are restrained by the tail in such a way that

their various parts are of equal power, and so the tail becomes partly lowered and the bird is raised forward slightly. (*K* 10 *v.*)

When the kite rises or sinks without beating its wings, it holds them slanting, and keeps the tail slanting in the same way but not to the same extent, for if this were so the bird would fall to the ground by the line of the slant of the wings and of the tail; but as this tail is away from the centre of the bird's length it meets with somewhat more resistance than the wings, and this in consequence checks its movement, and so the tail has less movement than the wings. Necessity causes the bird to move with a circular motion, and as the tail is less slanting, so in proportion the circles are less in diameter, and so also conversely. (*K* 60 [11] *r.* 59 [10] *v.*)

When the bird is carried along by the wind and wishes to turn quickly towards it, it will then enter beneath the wind with the wing turned towards it; and then with the feathers of the tail turned towards the wind, it will enter upon it, and so by the help of the wind striking upon its tail it turns much more rapidly. (*K* 9 *v.*)

If one of the wings is lowered rapidly and then folded the bird drops a little on that side; and if it is lowered rapidly and extended the bird drops on the opposite side; and if it is lowered slowly and extended the bird moves in a circle round this wing, falling as it proceeds; and if it is lowered slowly and with hesitation, and folded up, then the bird descends in curves on that side. (*K* 4 *r.* 3 *v.*)

All birds driven by the water or by the wind keep their heads in the direction from whence the water or the wind are coming. They do this in order to prevent the wind or the water penetrating up from the extremities to the roots of the feathers, so that each of the feathers may be pressed against another, and thus they may remain drier and warmer. (*K* 3 *v.*)

The bird rises to a height in a straight line without beating its wings when the reflex current of the wind strikes it from underneath. (*K* 3 *r.*)

III

When the kite in descending turns itself right over and pierces the air head downwards, it is forced to bend the tail as far as it can in the opposite direction to that which it desires to follow; and then again bending the tail swiftly, according to the direction in which it wishes to turn, the change in the bird's course corresponds to the turn of the tail, like the rudder of a ship which when turned turns the ship, but in the opposite direction.

When the wind is about to throw the bird backwards then the bird draws together the shoulders of its wings, so that its weight is massed more to the front than it was at first, and consequently the part that is heaviest is first in its descent, while in addition the tail is spread out and bent down. (*L* 62 *r.*)

The kite and the other birds which move their wings only a little way, go in search of the current of the

wind; and when the wind is blowing at a height they may be seen at a great elevation, but if it is blowing low down then they remain low.

When there is no wind stirring in the air then the kite beats its wings more rapidly in its flight, in such a way that it rises to a height and acquires an impetus; with which impetus, dropping then very gradually, it can travel for a great distance without moving its wings.

And when it has descended it does the same over again, and so continues for many times in succession.

This method of descending without moving the wings serves it as a means of resting in the air after the fatigue of the above mentioned beating of the wings.

All the birds which fly in spurts rise to a height by beating their wings; and during their descent they proceed to rest themselves, for while descending they do not beat their wings. (*Sul Volo degli Uccelli* 6[5]*v.*)

The swallow has its wings quite different from those of the kite, for it is very narrow in the shoulder and long in the span of the wing. Its stroke when it flies is made up of two distinct actions, that is the span of the wing is spread out like an oar in the direction of the tail, the shoulder towards the earth; and in this way while the one movement impels it forward, the other keeps it at its height, and the two combined carry it a stage onwards wherever it pleases. (*C. A.* 369 *r. a.*)

The thrushes and other small birds are able to make headway against the course of the wind, because they fly in spurts; that is they take a long course below

the wind, by dropping in a slanting direction towards the ground, with their wings half closed, and they then open the wings and catch the wind in them with their reverse movement, and so rise to a height; and then they drop again in the same way. (*C. A.* 313 *r. b.*)

Remember that your bird should have no other model than the bat, because its membranes serve as an armour or rather as a means of binding together the pieces of its armour, that is the framework of the wings.

And if you take as your pattern the wings of feathered birds, these are more powerful in structure of bone and sinew because they are penetrable, that is to say the feathers are separated from one another and the air passes through them. But the bat is aided by its membrane which binds the whole together and is not penetrated by the air. (*Sul Volo degli Uccelli*, 16 [15] *r.*)

OF THE BIRD'S MOVEMENT

Of whether birds when continually descending without beating their wings will proceed a greater distance in one sustained curve, or by frequently making some reflex movement; and whether when they wish to pass in flight from one spot to another they will go more quickly by making impetuous, headlong movements, and then rising up with reflex movement and again making a fresh descent, and so continuing.—To speak of this subject you must needs in the first book explain the nature of the resistance of the air, in the second the anatomy of the bird and of its wings, in the third the method of working of the wings in their various movements,

in the fourth the power of the wings and of the tail, at such time as the wings are not being moved and the wind is favourable, to serve as a guide in different movements.

Dissect the bat, study it carefully, and on this model construct the machine. (*F* 41 *v.*)

IV

A bird is an instrument working according to mathematical law, which instrument it is within the capacity of man to reproduce with all its movements, but not with a corresponding degree of strength, though it is deficient only in the power of maintaining equilibrium. We may therefore say that such an instrument constructed by man is lacking in nothing except the life of the bird, and this life must needs be supplied from that of man.

The life which resides in the bird's members will without doubt better conform to their needs than will that of man which is separated from them, and especially in the almost imperceptible movements which preserve equilibrium. But since we see that the bird is equipped for many obvious varieties of movements, we are able from this experience to deduce that the most rudimentary of these movements will be capable of being comprehended by man's understanding; and that he will to a great extent be able to provide against the destruction of that instrument of which he has himself become the living principle and the propeller.

(*C. A.* 161 *r. a.*)

There is as much pressure exerted by a substance against the air as by the air against the substance.

Observe how the beating of its wings against the air suffices to bear up the weight of the eagle in the highly rarefied air which borders on the fiery element! Observe also how the air moving over the sea, beaten back by the bellying sails, causes the heavily laden ship to glide onwards! So that by adducing and expounding the reasons of these things you may be able to realise that man when he has great wings attached to him, by exerting his strength against the resistance of the air and conquering it, is enabled to subdue it and to raise himself upon it. (*C. A.* 381 *v.* *a.*)

Suppose that here there is a body suspended, which resembles that of a bird, and that its tail is twisted to an angle of various different degrees; you will be able by means of this to deduce a general rule as to the various twists and turns in the movements of birds occasioned by the bending of their tails.

In all the varieties of movements the heaviest part of the thing which moves becomes the guide of the movement. (*L* 61 *v.*)

The bird I have described ought to be able by the help of the wind to rise to a great height, and this will prove to be its safety; since even if all the above-mentioned revolutions were to befall it, it would still have time to regain a condition of equilibrium; provided that its various parts have a great power of resistance, so that they can safely withstand the fury and violence of the descent, by the aid of the defences which I have

mentioned; and its joints should be made of strong tanned hide, and sewn with cords of very strong raw silk. And let no one encumber himself with iron bands, for these are very soon broken at the joints or else they become worn out, and consequently it is well not to encumber one's self with them.

(*Sul Volo degli Uccelli*, 8 [7] *r.*)

AN ARGUMENT TO DISPOSE OF THE OBJECTIONS TO THE ATTEMPT

You will perhaps say that the sinews and muscles of a bird are incomparably more powerful than those of man, because all the girth of so many muscles and of the fleshy parts of the breast goes to aid and increase the movement of the wings, while the bone in the breast is all in one piece and consequently affords the bird very great power, the wings also being all covered with a network of thick sinews and other very strong ligaments of gristle, and the skin being very thick with various muscles. But the reply to this is that such great strength gives it a reserve of power beyond what it ordinarily uses to support itself on its wings, since it is necessary for it whenever it may so desire either to double or treble its rate of speed in order to escape from its pursuer or to follow its prey. Consequently in such a case it becomes necessary for it to put forth double or treble the amount of effort, and in addition to this to carry through the air in its talons a weight corresponding to its own weight. So one sees a falcon carrying a duck and an eagle carrying a hare; which circumstance shows clearly enough where the excess of strength is spent; for

they need but little force in order to sustain themselves, and to balance themselves on their wings, and flap them in the pathway of the wind and so direct the course of their journeyings; and a slight movement of the wings is sufficient for this, and the movement will be slower in proportion as the bird is greater in size.

Man is also possessed of a greater amount of strength in his legs than is required by his weight. And in order to show the truth of this, place a man to stand upon the sea-shore, and observe how far the marks of his feet sink in; and then set another man on his back, and you will see how much deeper the marks of his feet will be. Then take away the man from his back, and set him to jump straight up as high as he can; you will then find that the marks of his feet make a deeper impression where he has jumped than where he has had the other man on his back. This affords us a double proof that man is possessed of more than twice the amount of strength that is required to enable him to support himself.

(*Sul Volo degli Uccelli* 17 [16] *r.*)

BOOK III

ART

I. PAINTING, POETRY, AND SCULPTURE

HOW PAINTING SURPASSES ALL HUMAN WORKS BY REASON OF THE SUBTLE POSSIBILITIES WHICH IT CONTAINS

THE eye, which is called the window of the soul, is the chief means whereby the understanding may most fully and abundantly appreciate the infinite works of nature; and the ear is the second inasmuch as it acquires its importance from the fact that it hears the things which the eye has seen. If you historians, or poets, or mathematicians had never seen things with your eyes you would be ill able to describe them in your writings. And if you, O poet, represent a story by depicting it with your pen, the painter with his brush will so render it as to be more easily satisfying and less tedious to understand. If you call painting 'dumb poetry,' then the painter may say of the poet that his art is 'blind painting.' Consider then which is the more grievous affliction, to be blind or be dumb! Although the poet has as wide a choice of subjects as the painter, his creations fail to afford as much satisfaction to mankind as do paintings, for while poetry attempts with words to represent forms, actions, and scenes, the painter

employs the exact images of the forms in order to reproduce these forms. Consider, then, which is more fundamental to man, the name of man or his image? The name changes with change of country; the form is unchanged except by death.

And if the poet serves the understanding by way of the ear, the painter does so by the eye which is the nobler sense. I will only cite as an instance of this how if a good painter represents the fury of a battle and a poet also describes one, and the two descriptions are shown together to the public, you will soon see which will draw most of the spectators, and where there will be most discussion, to which most praise will be given and which will satisfy the more. There is no doubt that the painting which is by far the more useful and beautiful will give the greater pleasure. Inscribe in any place the name of God and set opposite to it his image, you will see which will be held in greater reverence!

Since painting embraces within itself all the forms of nature you have nothing omitted except the names, and these are not universal like the forms. If you have the results of her processes we have the processes of her results.

Take the case of a poet describing the beauties of a lady to her lover and that of a painter who makes a portrait of her; you will see whither nature will the more incline the enamoured judge. Surely the proof of the matter ought to rest upon the verdict of experience!

You have set painting among the mechanical arts! Truly were painters as ready equipped as you are to praise their own works in writing I doubt whether it would

endure the reproach of so vile a name. If you call it mechanical because it is by manual work that the hands represent what the imagination creates, your writers are setting down with the pen by manual work what originates in the mind. If you call it mechanical because it is done for money, who fall into this error—if indeed it can be called an error—more than you yourselves? If you lecture for the Schools do you not go to whoever pays you the most? Do you do any work without some reward? And yet I do not say this in order to censure such opinions, for every labour looks for its reward. And if the poet should say, 'I will create a fiction which shall express great things,' so likewise will the painter also, for even so Apelles made the Calumny. If you should say that poetry is the more enduring,—to this I would reply that the works of a coppersmith are more enduring still, since time preserves them longer than either your works or ours; nevertheless they show but little imagination; and painting if it be done upon copper in enamel colours can be made far more enduring.

In Art we may be said to be grandsons unto God. If poetry treats of moral philosophy, painting has to do with natural philosophy; if the one describes the workings of the mind, the other considers what the mind effects by movements of the body; if the one dismays folk by hellish fictions, the other does the like by showing the same things in action. Suppose the poet sets himself to represent some image of beauty or terror, something vile and foul, or some monstrous thing, in contest with the painter, and suppose in his own way

he makes a change of forms at his pleasure, will not the painter still satisfy the more? Have we not seen pictures which bear so close a resemblance to the actual thing that they have deceived both men and beasts?

If you know how to describe and write down the appearance of the forms, the painter can make them so that they appear enlivened with lights and shadows which create the very expression of the faces; herein you cannot attain with the pen where he attains with the brush. (*Bib. Nat. MS.* 2038, 19 *r. and v.*, 20 *r.*

So soon as the poet ceases to represent in words what exists in nature, then the poet ceases to be like the painter; for if the poet were to leave such representation and describe the polished and persuasive words of him whom he wishes to represent speaking, then he becomes an orator and is no longer a poet or a painter; and if he speaks of the heavens he becomes an astrologer; and a philosopher and theologian when discoursing of the works of nature or of God. But if he confines himself to the representation of specific objects he will vie with the painter only if by his words he can satisfy the eye to the same extent as he does.

(*Windsor MSS. Notes et dessins sur la Génération* [*Rouveyre*], 1 *r.*).

HOW HE WHO DESPISES PAINTING HAS NO LOVE FOR THE PHILOSOPHY IN NATURE

If you despise painting, which is the sole imitator of all the visible works of nature, it is certain that you will be despising a subtle invention which with philosophical and ingenious speculation takes as its theme all the various

kinds of forms, airs, and scenes, plants, animals, grasses and flowers, which are surrounded by light and shade. And this truly is a science and the true-born daughter of nature, since painting is the offspring of nature. But in order to speak more correctly we may call it the grandchild of nature; for all visible things derive their existence from nature, and from these same things is born painting. So therefore we may justly speak of it as the grandchild of nature and as related to God Himself. (*MS.* 2038 *Bib. Nat.* 20 *r.*)

THAT SCULPTURE IS LESS INTELLECTUAL THAN PAINTING, AND LACKS MANY OF ITS NATURAL PARTS

As practising myself the art of sculpture no less than that of painting, and doing both the one and the other in the same degree, it seems to me that without suspicion of unfairness I may venture to give an opinion as to which of the two is the more intellectual, and of the greater difficulty and perfection. In the first place sculpture is dependent on certain lights, namely those from above, while a picture carries everywhere with it its own light and shade; light and shade therefore are essential to sculpture. In this respect the sculptor is aided by the nature of the relief which produces these of its own accord, but the painter artificially creates them by his art in places where nature would normally do the like. The sculptor cannot render the difference in the varying natures of the colours of objects; painting does not fail to do so in any particular. The lines of perspective of sculptors do not seem in any way true; those of painters may appear to extend a hundred miles beyond

the work itself. The effects of aerial perspective are outside the scope of their work; they can neither represent transparent bodies nor luminous bodies nor angles of reflection nor shining bodies such as mirrors and like things of glittering surface, nor mists, nor dull weather, nor an infinite number of things which I forbear to mention lest they should prove wearisome.

The one advantage which it has is that of offering greater resistance to time; yet painting offers a like resistance if it is done upon thick copper covered with white enamel and then painted upon with enamel colours and placed in a fire and fused. In degree of permanence it then surpasses even sculpture.

It may be urged that if a mistake is made it is not easy to set it right, but it is a poor line of argument to attempt to prove that the fact of a mistake being irremediable makes the work more noble. I should say indeed that it is more difficult to correct the mind of the master who makes such mistakes than the work which he has spoiled. We know very well that a good experienced painter will not make such mistakes; on the contrary following sound rules he will proceed by removing so little at a time that his work will progress well. The sculptor also if he is working in clay or wax can either take away from it or add to it, and when the model is completed it is easy to cast it in bronze; and this is the last process and it is the most enduring form of sculpture, since that which is only in marble is liable to be destroyed, but not when done in bronze.

But painting done upon copper, which by the methods in use in painting may be either taken from or altered,

is like the bronze, for when you have first made the model for this in wax it can still be either reduced or altered. While the sculpture in bronze is imperishable, this painting upon copper and enamel is absolutely eternal; and while bronze remains dark and rough, this is full of an infinite variety of varied and lovely colours, of which I have already made mention. But if you would have me speak only of panel painting I am content to give an opinion between it and sculpture by saying that painting is more beautiful, more imaginative, and richer in resource, while sculpture is more enduring, but excels in nothing else. Sculpture reveals what it is with little effort; painting seems a thing miraculous, making things intangible appear tangible, presenting in relief things which are flat, in distance things near at hand. In fact painting is adorned with infinite possibilities of which sculpture can make no use.

(*MS.* 2038, *Bib. Nat.* 25 *r. and* 24 *v.*)

The sculptor cannot represent transparent or luminous things. (*C. A.* 215 *v. d.*)

OF STATUES

If you wish to make a figure of marble make first one of clay, and after you have finished it and let it dry, set it in a case, which should be sufficiently large that—after the figure has been taken out—it can hold the block of marble wherein you purpose to lay bare a figure resembling that in clay. Then after you have placed the clay figure inside this case make pegs so that they fit exactly into holes in the case, and drive them in at each hole until each white peg touches the figure at a different

PLATE 7

GENISTA TINCTORIA
(*Dyers' Greenweed*)

QUERCUS ROBUR PEDUNCULATA
(*Stalked Oak*)

Face p. 163

spot; stain black such parts of the pegs as project out of the case, and make a distinguishing mark for each peg and for its hole so that you may fit them together at your ease. Then take the clay model out of the case and place the block of marble in it, and take away from the marble sufficient for all the pegs to be hidden in the holes up to their marks, and in order to be able to do this better make the case so that the whole of it can be lifted up and the bottom may still remain under the marble; and by this means you will be able to use the cutting tools with great readiness. (*A* 43 *r.*)

II. THE PRECEPTS OF THE PAINTER

PAINTING

The mind of the painter should be like a mirror which always takes the colour of the thing that it reflects and which is filled by as many images as there are things placed before it. Knowing therefore that you cannot be a good master unless you have a universal power of representing by your art all the varieties of the forms which nature produces,—which indeed you will not know how to do unless you see them and retain them in your mind,—look to it, O Painter, that when you go into the fields you give your attention to the various objects and look carefully in turn first at one thing and then at another, making a bundle of different things selected and chosen from among those of less value. And do not after the manner of some painters who when tired by imaginative work, lay aside their task and take exercise by walking in order to find relaxation, keeping, however, such weariness of mind as prevents them either seeing or

being conscious of different objects; so that often when meeting friends or relatives, and being saluted by them, although they may see and hear them they know them no more than if they had met only so much air.

(*MS.* 2038, *Bib. Nat.* 2 *r.*)

HOW FROM AGE TO AGE THE ART OF PAINTING CONTINUALLY DECLINES AND DETERIORATES WHEN PAINTERS HAVE NO OTHER STANDARD THAN WORK ALREADY DONE

The painter will produce pictures of little merit if he takes the works of others as his standard; but if he will apply himself to learn from the objects of nature he will produce good results. This we see was the case with the painters who came after the time of the Romans, for they continually imitated each other, and from age to age their art steadily declined.

After these came Giotto the Florentine, and he,—reared in mountain solitudes, inhabited only by goats and such like beasts—turning straight from nature to his art, began to draw on the rocks the movements of the goats which he was tending, and so began to draw the figures of all the animals which were to be found in the country, in such a way that after much study he not only surpassed the masters of his own time but all those of many preceding centuries. After him art again declined, because all were imitating paintings already done; and so for centuries it continued to decline until such time as Tommaso the Florentine, nicknamed Masaccio, showed by the perfection of his work how those who took as their standard anything other than

nature, the supreme guide of all the masters, were wearying themselves in vain. Similarly I would say as to these mathematical subjects, that those who study only the authorities and not the works of nature are in art the grandsons and not the sons of nature, which is the supreme guide of the good authorities.

Mark the supreme folly of those who censure such as learn from nature, leaving uncensured the authorities who were the disciples of this same nature! (*C. A.* 141 *r. b.*)

THE LIFE OF THE PAINTER IN THE COUNTRY

The painter requires such knowledge of mathematics as belongs to painting, and severance from companions who are not in sympathy with his studies, and his brain should have the power of adapting itself to the tenor of the objects which present themselves before it, and he should be freed from all other cares.

And if while considering and examining one subject a second should intervene, as happens when an object occupies the mind, he ought to decide which of these subjects presents greater difficulties in investigation, and follow that until it becomes entirely clear, and afterwards pursue the investigation of the other. And above all he should keep his mind as clear as the surface of a mirror, which becomes changed to as many different colours as are those of the objects within it, and his companions should resemble him in a taste for these studies, and if he fail to find any such he should accustom himself to be alone in his investigations, for in the end he will find no more profitable companionship. (*C. A.* 184 *v. c.*)

OF THE LIFE OF THE PAINTER IN HIS STUDIO.

The painter or draughtsman ought to be solitary in order that the well-being of the body may not sap the vigour of the mind, and more especially when he is occupied with the consideration and investigation of things which by being continually present before his eyes furnish food to be treasured up in the memory.

If you are alone you belong entirely to yourself; if you are accompanied even by one companion you belong only half to yourself, or even less in proportion to the thoughtlessness of his conduct; and if you have more than one companion you will fall more deeply into the same plight.

If you should say, 'I will take my own course; I will retire apart, so that I may be the better able to investigate the forms of natural objects,' then I say this must needs turn out badly, for you will not be able to prevent yourself from often lending an ear to their chatter; and not being able to serve two masters, you will discharge badly the duty of companionship and even worse that of endeavouring to realise your conceptions in art.

But suppose you say, 'I will withdraw so far apart that their words shall not reach me nor in any way disturb me,' I reply that in this case you will be looked upon as mad, and bear in mind that in so doing you will then be solitary.

If you must have companionship choose it from your studio; it may then help you to obtain the advantages which result from different methods of study. All other companionship may prove extremely harmful.

(*MS.* 2038, *Bib. Nat.* 27 *v. and r.*)

HOW THE PAINTER IS NOT WORTHY OF PRAISE UNLESS HE IS UNIVERSAL

We may frankly admit that certain people deceive themselves who apply the title 'a good master' to a painter who can only do the head or the figure well. Surely it is no great achievement if by studying one thing only during his whole lifetime he attain to some degree of excellence therein! But since, as we know, painting embraces and contains within itself all the things which nature produces or which result from the fortuitous actions of men, and in short whatever can be comprehended by the eyes, it would seem to me that he is but a poor master who only makes a single figure well. For do you not see how many and how varied are the actions which are performed by men alone? Do you not see how many different kinds of animals there are, and also of trees and plants and flowers? What variety of hilly and level places, of springs, rivers, cities, public and private buildings; of instruments fitted for man's use; of divers costumes, ornaments, and arts?—Things which should be rendered with equal facility and grace by whoever you wish to call a good painter.

(*MS.* 2038, *Bib. Nat.* 25 *v.*)

HOW THE MIRROR IS THE MASTER OF PAINTERS

When you wish to see whether the general effect of your picture corresponds with that of the object represented after nature, take a mirror and set it so that it reflects the actual thing, and then compare the reflection with your picture, and consider carefully whether

the subject of the two images is in conformity with both, studying especially the mirror. The mirror ought to be taken as a guide,—that is the flat mirror—for within its surface substances have many points of resemblance to a picture; namely that you see the picture made upon one plane showing things which appear in relief, and the mirror upon one plane does the same. The picture is one single surface, and the mirror is the same. The picture is intangible, inasmuch as what appears round and detached cannot be enclosed within the hands, and the mirror is the same. The mirror and the picture present the images of things surrounded by shadow and light, and each alike seems to project considerably from the plane of its surface. And since you know that the mirror presents detached things to you by means of outlines and shadows and lights, and since you have moreover amongst your colours more powerful shadows and lights than those of the mirror, it is certain that if you but know well how to compose your picture it will also seem a natural thing seen in a great mirror. (*MS.* 2038, *Bib. Nat.* 24 *v.*)

Painters oftentimes deceive themselves by representing water in which they render visible what is seen by man; whereas the water sees the object from one side and the man sees it from the other; and it frequently happens that the painter will see a thing from above and the water sees it from beneath, and so the same body is seen in front and behind, and above and below, for the water reflects the image of the object in one way and the eye sees it in another. (*C. A.* 354 *v. a.*)

OF JUDGING YOUR OWN PICTURE

We know well that mistakes are more easily detected in the works of others than in one's own, and that oftentimes while censuring the small faults of others you will overlook your own great faults. In order to avoid such ignorance make yourself first of all a master of perspective, then gain a complete knowledge of the proportions of man and other animals, and also make yourself a good architect, that is in so far as concerns the form of the buildings and of the other things which are upon the earth, which are infinite in form ; and the more knowledge you have of these the more will your work be worthy of praise ; and for those things in which you have no practice do not disdain to draw from nature. But to return to what has been promised above, I say that when you are painting you should take a flat mirror and often look at your work within it, and it will then be seen in reverse, and will appear to be by the hand of some other master, and you will be better able to judge of its faults than in any other way. It is also a good plan every now and then to go away and have a little relaxation ; for then when you come back to the work your judgment will be surer, since to remain constantly at work will cause you to lose the power of judgment. It is also advisable to go some distance away, because then the work appears smaller, and more of it is taken in at a glance, and a lack of harmony or proportion in the various parts and in the colours of the objects is more readily seen. (*MS.* 2038, *Bib. Nat.* 28 *r.*)

OF VARIETY IN FIGURES

The painter ought to strive at being universal, for there is a great lack of dignity in doing one thing well and another badly, like many who study only the measurements and proportions of the nude figure and do not seek after its variety ; for a man may be properly proportioned and yet be fat and short or long and thin, or medium. And whoever does not take count of these varieties will always make his figures in one mould so that they will all appear sisters, and this practice deserves severe censure.

OF THE ORDER OF ACQUIRING THIS UNIVERSALITY

It is an easy matter for whoever knows how to represent man to afterwards acquire this universality, for all the animals which live upon the earth resemble each other in their limbs, that is in muscles, sinews, and bones, and they do not vary at all, except in length or thickness as will be shown in the Anatomy. There are also the aquatic animals, of which there are many different kinds ; and with regard to these I do not advise the painter to make a fixed standard, for they are of almost infinite variety ; and the same is also true of the insect world. (*G* 5 *v.*)

HOW THE PAINTER OUGHT TO BE DESIROUS OF HEARING EVERY MAN'S OPINION AS TO THE PROGRESS OF HIS WORK

Surely when a man is painting a picture he ought not to refuse to hear any man's opinion, for we know very

well that though a man may not be a painter, he has a true conception of the form of another man and will judge aright whether he is hump-backed or has one shoulder high or low, or whether he has a large mouth or nose or other defects.

Since then we recognise that men are able to form a true judgment as to the works of nature, how much the more does it behove us to admit that they are able to judge our faults. For you know how much a man is deceived in his own works, and if you do not recognise this in your own case observe it in others and then you will profit by their mistakes. Therefore you should be desirous of hearing patiently the opinions of others, and consider and reflect carefully whether or no he who censures you has reason for his censure; and correct your work if you find that he is right, but if not, then let it seem that you have not understood him, or—in case he is a man whom you esteem—show him by argument why it is that he is mistaken.

(*MS.* 2038, *Bib. Nat.* 26 *r.*)

HOW IN WORKS OF IMPORTANCE A MAN SHOULD NOT TRUST SO ENTIRELY TO HIS MEMORY AS TO DISDAIN TO DRAW FROM NATURE

Any master who let it be understood that he could himself recall all the forms and effects of nature would certainly appear to me to be endowed with great ignorance, considering that these effects are infinite and that our memory is not of so great capacity as to suffice thereto. Do you therefore, O Painter, take care lest the

greed for gain prove a stronger incentive than renown in art, for to gain this renown is a far greater thing than is the renown of riches. For these, then, and other reasons which might be given, you should apply yourself first of all to drawing in order to present to the eye in visible form the purpose and invention created originally in your imagination; then proceed to take from or add to it until you satisfy yourself; then have men arranged as models draped or nude in the way in which you have disposed them in your work; and make the proportions and size in accordance with perspective, so that no part of the work remains that is not so counselled by reason and by the effects in nature. And this will be the way to make yourself renowned in your art.

(*MS.* 2038, *Bib. Nat.* 26 *r.*)

OF STUDYING AS SOON AS YOU ARE AWAKE OR BEFORE YOU GO TO SLEEP IN BED IN THE DARK

I have proved in my own case that it is of no small benefit on finding oneself in bed in the dark to go over again in the imagination the main outlines of the forms previously studied, or of other noteworthy things conceived by ingenious speculation; and this exercise is entirely to be commended, and it is useful in fixing things in the memory. (*MS.* 2038, *Bib. Nat.* 26 *r.*)

A WAY TO STIMULATE AND AROUSE THE MIND TO VARIOUS INVENTIONS

I will not refrain from setting among these precepts

a new device for consideration which, although it may appear trivial and almost ludicrous, is nevertheless of great utility in arousing the mind to various inventions. And this is that if you look at any walls spotted with various stains or with a mixture of different kinds of stones, if you are about to invent some scene you will be able to see in it a resemblance to various different landscapes adorned with mountains, rivers, rocks, trees, plains, wide valleys, and various groups of hills. You will also be able to see divers combats and figures in quick movement, and strange expressions of faces, and outlandish costumes, and an infinite number of things which you can then reduce into separate and well conceived forms. With such walls and blends of different stones it comes about as it does with the sound of bells, in whose clanging you may discover every name and word that you can imagine.

(*MS.* 2038, *Bib. Nat.* 22 *v.*)

OF THE GAMES IN WHICH DRAUGHTSMEN SHOULD INDULGE

When you draughtsmen wish to find some profitable recreation in games you should always practise things which may be of use in your profession, that is by giving your eye accuracy of judgment so that it may know how to estimate the truth as to the length and breadth of objects. So in order to accustom the mind to such things let one of you draw a straight line anywhere on a wall, and then let each of you take a light

rush or straw in his hand, and let each cut his own to the length which the first line appears to him when he is distant from it a space of ten braccia, and then let each go up to the copy in order to measure it against the length which he has judged it to be, and he whose measure comes nearest to the length of the copy has done best and is the winner, and he should receive from all the prize which was previously agreed upon by you. Furthermore you should take measurements foreshortened, that is, you should take a spear or some other stick and look before you to a certain point of distance, and then let each set himself to reckon how many times this measure is contained in the said distance. Another thing is to see who can draw the best line one braccio in length, and this may be tested by tightly drawn thread. Diversions such as these enable the eye to acquire accuracy of judgment, and this is the primary essential of painting. (*MS.* 2038, *Bib. Nat.* 26 *v.*)

Painters have a good opportunity of observing actions in players, especially at ball or tennis or with the mallet when they are contending together, better indeed than in any other place or exercise. (*I* 48 *v.*)

OF THE PROPER TIME FOR STUDYING THE SELECTION OF SUBJECTS

The winter evenings should be spent by youthful students in study of the things prepared during the summer; that is, all the drawings from the nude which you have made in the summer should be brought

together, and you should make a choice from among them of the best limbs and bodies and practise at these and learn them by heart.

OF ATTITUDES

Afterwards in the ensuing summer you should make choice of some one who has a good presence, and has not been brought up to wear doublets, and whose figure consequently has not lost its natural bearing, and make him go through various graceful and elegant movements. If he fails to show the muscles very clearly within the outlines of the limbs, this is of no consequence. It is enough for you merely to obtain good attitudes from the figure, and you can correct the limbs by those which you have studied during the winter.

(*MS.* 2038, *Bib. Nat.* 27 *r.*)

AN INDICATION WHETHER A YOUTH HAS AN APTITUDE FOR PAINTING

There are many men who have a desire and love for drawing but no aptitude for it, and this can be discerned in children if they are not diligent and never finish their copies with shading.

The painter is not worthy of praise who only does one thing well, as the nude, or a head, or draperies, or animal life, or landscapes, or such other special subject, for there is no one so dull of understanding that after devoting himself to one subject only and continually practising at this, he will fail to do it well.

(*G* 25 *r.*)

PAINTING

Men and words are actual, and you, painter, if you do not know how to execute your figures, will be like an orator who does not know how to use his words. (*K* 110 [30] *v.*)

The painter who draws by practice and judgment of the eye without the use of reason, is like the mirror which reproduces within itself all the objects which are set opposite to it without knowledge of the same. (*C. A.* 76 *r. a.*)

THIS RULE OUGHT TO BE GIVEN TO CHILDREN WHO PAINT

We know clearly that the sight is one of the swiftest actions that can exist, for in the same instant it surveys an infinite number of forms; nevertheless it can only comprehend one thing at a time. To take an instance: you, O Reader, might at a glance look at the whole of this written page and you would instantly decide that it is full of various letters, but you will not recognise in this space of time either what letters they are or what they purport to say, and therefore it is necessary for you if you wish to gain a knowledge of these letters to take them word by word and line by line. Again, if you wish to go up to the summit of a building it will be necessary for you to ascend step by step, otherwise it will be impossible to reach the top. So I say to you whom nature inclines to this art, if you would have a true knowledge of the forms of different objects you

should commence with their details and not pass on to the second until the first is well in your memory and you have practised it. If you do otherwise you will be throwing away time, and to a certainty you will greatly prolong the period of study. And remember to acquire diligence rather than facility.

(*MS.* 2038, *Bib. Nat.* 28 *r.*)

HOW ONE OUGHT FIRST TO LEARN DILIGENCE RATHER THAN RAPID EXECUTION

If as draughtsman you wish to study well and profitably, accustom yourself when you are drawing to work slowly, and to determine between the various lights which possess the highest degree of brightness and in what measure, and similarly as to the shadows which are those that are darker than the rest, and in what manner they mingle together, and to compare their dimensions one with another ; and so with the contours to observe which way they are tending, and as to the lines what part of each is curved in one way or another, and where they are more or less conspicuous and consequently thick or fine ; and lastly to see that your shadows and lights may blend without strokes or lines in the manner of smoke. And when you shall have trained your hand and judgment with this degree of care, it will speedily come to pass that you will have no need to take thought thereto. (*MS.* 2038, *Bib. Nat.* 27 *v.*)

OF THE ORDER TO BE OBSERVED IN STUDY

I say that one ought first to learn about the limbs and how they are worked, and after having completed

this knowledge one ought to study their actions in the different conditions in which men are placed, and thirdly to devise figure compositions, the studies for these being taken from natural actions made on occasion as opportunities offered, and one should be on the watch in the streets and squares and fields, and there make sketches with rapid strokes to represent features, that is for a head one may make an *o*, and for an arm a straight or curved line, and so in like manner for the legs and trunk, afterwards when back at home working up these notes in a completed form.

My opponent says that in order to gain experience and to learn how to work readily, it is better that the first period of study should be spent in copying various compositions made by different masters either on sheets of paper or on walls, since from these one acquires rapidity in execution and a good method. But to this it may be replied that the ensuing method would be good if it was founded upon works that were excellent in composition and by diligent masters; and since such masters are so rare that few are to be found, it is safer to go direct to the works of nature than to those which have been imitated from her originals with great deterioration and thereby to acquire a bad method, for he who has access to the fountain does not go to the water-pot. (*C. A.* 199 *v. a.*)

THE ORDER OF LEARNING TO DRAW

First of all copy drawings by a good master made by his art from nature and not as exercises; then from a

relief, keeping by you a drawing done from the same relief; then from a good model, and of this you ought to make a practice. (*MS.* 2038, *Bib. Nat.* 33 *r.*)

OF THE WAY TO FIX IN YOUR MIND THE FORM OF A FACE

If you desire to acquire facility in keeping in your mind the expression of a face, first learn by heart the various different kinds of heads, eyes, noses, mouths, chins, throats, and also necks and shoulders. To take as an instance noses. They are of ten types: straight, bulbous, deep-set, prominent either above or below the centre, aquiline, regular, ape-like, round, and pointed. These divisions hold good as regards profile. Seen from in front noses are of twelve types: thick in the middle, thin in the middle, with the tip broad and narrow at the base, or narrow at the tip and broad at the base, with nostrils broad or narrow, or high or low, and with the openings either distended or hidden by the tip. And similarly you will find variety in the other features; of which things you ought to make studies from nature and so fix them in your mind. Or when you have to draw a face from memory, carry with you a small note-book in which you have noted down such features, and then when you have cast a glance at the face of the person whom you wish to draw, you can then look privately and see which nose or mouth has a resemblance to it, and make a tiny mark against it in order to recognise it again at home. Of monstrous faces I here say nothing, for they are kept in mind without difficulty.

(*MS.* 2038, *Bib. Nat.* 26 *v.*)

OF THE PARTS OF THE FACE

If nature had only one fixed standard for the proportions of the various parts, then the faces of all men would resemble each other to such a degree that it would be impossible to distinguish one from another; but she has varied the five parts of the face in such a way that although she has made an almost universal standard as to their size she has not observed it in the various conditions to such a degree as to prevent one from being clearly distinguished from another. (*C. A.* 119 *v. a.*)

OF THE ARRANGEMENT OF THE LIMBS

As regards the arrangement of the limbs, you should bear in mind that when you wish to represent one who by some chance has either to turn backwards or on one side you must not make him move his feet and all his limbs in the same direction as he turns his head; but you should show the process spreading itself and taking effect over the four sets of joints, namely those of the foot, the knee, the hip, and the neck. And if you let his weight rest on the right leg, you should make the knee of the left bend inwards; and the foot of it should be slightly raised on the outside, and the left shoulder should be somewhat lower than the right; and the nape of the neck should be exactly above the outer curve of the ankle of the left foot, and the left shoulder should be above the toe of the right foot in a perpendicular line. And always so dispose your figures that the direction in which the head is turned is not that in which the breast faces, since nature has for our con-

venience so formed the neck that it can easily serve the different occasions on which the eye desires to turn in various directions; and to this same organ the other joints are in part responsive. And if ever you show a man sitting with his hands at work upon something by his side, make the chest turn upon the hip-joints.

(*MS.* 2038, *Bib. Nat.* 30 *r.*)

OF PAINTING

If you have to represent a man either as moving or lifting or pulling or carrying a weight equal to his own weight how ought you to fit the legs under his body?

(*C. A.* 349 *r. b.*)

OF THE CONFORMITY OF THE LIMBS

Further I remind you to pay great attention in giving limbs to your figures so that they may not merely appear to harmonise with the size of the body but also with its age. So the limbs of youths should have few muscles and veins, and have a soft surface and be rounded and pleasing in colour; in men they should be sinewy and full of muscles; in old men the surface should be wrinkled, and rough and covered with veins, and with the sinews greatly protruding.

HOW LITTLE CHILDREN HAVE THEIR JOINTS THE REVERSE OF THOSE OF MEN IN THEIR THICKNESS

Little children have all the joints slender while the intervening parts are thick; and this is due to the fact that the joints are only covered by skin and there is no

flesh at all over them, and this skin acts as a sinew to gird and bind together the bones; and a flabby layer of flesh is found between one joint and the next shut in between the skin and the bone. But since the bones are thicker at the joints than between them, the flesh as the man grows up loses that superfluity which existed between the skin and the bone, and so the skin is drawn nearer to the bone and causes the limbs to seem more slender. But since there is nothing above the joints except cartilaginous and sinewy skin this cannot dry up, and not being dried up it does not shrink. So for these reasons the limbs of children are slender at the joints and thick between the joints, as is seen in the joints of the fingers, arms, and shoulders which are slender and have great dimples; and a man on the contrary has all the joints of fingers, arms, and legs thick, and where children have hollows men have the joints protruding. (*MS.* 2038, *Bib. Nat.* 28 *v.*)

OF THE GRACE OF THE LIMBS

The limbs should fit the body gracefully in harmony with the effect you wish the figure to produce; and if you desire to create a figure which shall possess a charm of its own, you should make it with limbs graceful and extended, without showing too many of the muscles, and the few which your purpose requires you to show indicate briefly, that is without giving them prominence and with the shadows not sharply defined, and the limbs, and especially the arms, should be easy, that is that no limb should be in a straight line with the part that adjoins it. And if the hips, which form as it were the poles of the man, are by his position placed so that the

right is higher than the left, you should make the top shoulder joint so that a line drawn from it perpendicularly falls on the most prominent part of the hip, and let this right shoulder be lower than the left. And let the hollow of the throat always be exactly over the middle of the joint of the foot which is resting on the ground. The leg which does not support the weight should have its knee below the other and near to the other leg.

The positions of the head and arms are numberless, and therefore I will not attempt to give any rule; it will suffice that they should be natural and pleasing and should bend and turn in various ways, with the joints moving freely so that they may not seem like pieces of wood. (*MS.* 2038, *Bib. Nat.* 29 *v.*)

PAINTING

O painter skilled in anatomy, beware lest the undue prominence of the bones, sinews, and muscles cause you to become a wooden painter from the desire to make your nude figures reveal all their emotions. And if you wish to remedy this you should consider in what way the muscles of old or lean persons cover or clothe the bones, and futhermore note the principle on which these same muscles fill up the spaces of the surface which come between them, and which are the muscles that never lose their prominence in any degree of fatness whatsoever, and which those whereof the tendons become indistinguishable at the least suggestion of it. And there are many cases when several muscles grow to look one from the increase of fat, and many in which when

any one becomes lean or old a single muscle divides into several; and in this treatise all their peculiarities shall be set forth each in its place, and especially with regard to the spaces that come between the joints of each limb. Further you should not fail to observe the variations of the aforesaid muscles round the joints of the limbs of any animal, due to the diversity of the movements of each limb; for on any side of these joints the indication of these muscles becomes completely lost by reason either of the increase or diminution of the flesh of which these muscles are composed. (*E* 19 *v.*)

OF PAINTING

It is a necessary thing for the painter in order to be able to fashion the limbs correctly in the positions and actions which they can represent in the nude, to know the anatomy of the sinews, bones, muscles and tendons in order to know in the various different movements and impulses which sinew or muscle is the cause of each movement, and to make only these prominent and thickened, and not the others all over the limb, as do many who in order to appear great draughtsmen make their nudes wooden and without grace, so that it seems rather as if you were looking at a sack of nuts than a human form or at a bundle of radishes rather than the muscles of nudes. (*L* 79 *r.*)

HOW IT IS NECESSARY FOR THE PAINTER TO KNOW THE INNER STRUCTURE OF MAN

The painter who has acquired a knowledge of the nature of the sinews, muscles, and tendons will know

exactly in the movement of any limb how many, and which of the sinews are the cause of it, and which muscle by its swelling is the cause of this sinew contracting, and which sinews having been changed into most delicate cartilage surround and contain the said muscle. So he will be able in divers ways and universally to indicate the various muscles by means of the different attitudes of his figures ; and he will not do like many who in different actions always make the same things appear in the arm, the back, the breast, and the legs ; for such things as these ought not to rank in the category of minor faults. (*MS.* 2038, 27 *r.*)

OF THE NATURE OF THE FOLDS OF DRAPERIES

That part of the fold which is furthest from the ends where it is confined will return most closely to its original form. Everything naturally desires to remain in its own state. Drapery being of uniform density and thickness on the reverse and on the right side, desires to lie flat ; consequently, whenever any folds or pleats force it to quit this condition of flatness, it obeys the law of this force in that part of itself where it is most constrained, and the part furthest away from such constraint you will find return most nearly to its original state, that is to say, lying extended and full.

(*MS.* 2038, *Bib. Nat.* 4 *r.*)

How one ought not to give drapery a confusion of many folds, but only make them where it is held by the hands or arms, and the rest may be suffered to fall simply where its nature draws it : and do not let the contour

of the figure be broken by too many lines or interrupted folds.

How draperies should be drawn from nature: that is, if you wish to represent woollen cloth draw the folds from the same material, and if it is to be silk, or fine cloth, or homespun, or of linen, or crape, show the different nature of the folds in each; and do not make a costume as many make it from models covered with pieces of paper or thin leather, for you will be deceiving yourself greatly. (*MS.* 2038, *Bib. Nat.* 17 *v.*)

OF THE FEW FOLDS IN DRAPERIES

How figures when dressed in a cloak ought not to show the shape to such an extent that the cloak seems to be next to the flesh; for surely you would not wish that the cloak should be next the flesh since you must realise that between the cloak and the flesh are other garments which prevent the shape of the limbs from being visible and appearing through the cloak. And those limbs which you make visible make thick of their kind so that there may seem to be other garments there under the cloak. And you should only allow the almost identical thickness of the limbs to be visible in a nymph or an angel, for these are represented clad in light draperies, which by the blowing of the wind are driven and pressed against the various limbs of the figures.

(*MS.* 2038, *Bib. Nat.* 18 *r.*)

OF PAINTING

In order to produce the same effect of action in a picture on the part of an old man and a young, you

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must make the action of the young man appear more vigorous in proportion as he is more powerful than the old man, and you will make the same difference between a young man and an infant. (*C. A.* 349 *r. b.*)

Let the movements of men be such as are in keeping with their dignity or meanness. (*C. A.* 345 *v. b.*)

Make your work to be in keeping with your purpose and design; that is, when you make your figure you should consider carefully who it is and what you wish it to be doing. (*C. A.* 349 *r. b.*)

PRECEPTS OF PAINTING

Let the sketches for historical subjects be rapid, and the working of the limbs not too much finished. Content yourself with merely giving the positions of these limbs which you will then be able at your leisure to finish as you please. (*MS.* 2038, *Bib. Nat.* 8 *v.*)

The youth ought first to learn perspective, then the proportions of everything, then he should learn from the hand of a good master in order to accustom himself to good limbs; then from nature in order to confirm for himself the reasons for what he has learnt; then for a time he should study the work of different masters: then make it a habit to practise and work at his art.

How the first picture was nothing but a line which surrounded the shadow of a man made by the sun upon a wall.

How historical pictures ought not to be crowded and confused by many figures.

How old men should be shown with slow, listless

movements, with the legs bent at the knees when they are standing up, with the feet parallel and separated one from another, the spine bent low, the head leaning forward, and the arms not too far apart.

How women should be represented in modest attitudes, with legs close together, arms folded, and with their heads low and bending sideways.

How old women should be represented as bold, with swift, passionate movements like the infernal furies, and these movements should seem quicker in the arms and heads than in the legs.

Little children should be represented when sitting as twisting themselves about with quick movements, and in shy, timid attitudes when standing up.

(*MS.* 2038, *Bib. Nat.* 17 *v.*)

OF THE METHOD OF LEARNING ARIGHT HOW TO COMPOSE GROUPS OF FIGURES IN HISTORICAL PICTURES

When you have thoroughly learnt perspective, and have fixed in your memory all the various parts and forms of things, you should often amuse yourself when you take a walk for recreation, in watching and taking note of the attitudes and actions of men as they talk and dispute, or laugh or come to blows one with another, both their actions and those of the bystanders who either intervene or stand looking on at these things; noting these down with rapid strokes in this way,[1] in a little pocket-book, which you ought always to carry with you. And let this be of tinted paper, so that it may not be rubbed out; but you should change the old for a new

[1] Sketch of figure in text of MS.

one, for these are not things to be rubbed out but preserved with the utmost diligence; for there is such an infinite number of forms and actions of things that the memory is incapable of preserving them, and therefore you should keep those [sketches] as your patterns and teachers. (*MS.* 2038, *Bib. Nat.* 27 *v.*

WHY THE REPRESENTING OF GROUPS OF FIGURES ONE ABOVE ANOTHER IS TO BE AVOIDED

This custom, which is universally adopted by painters for the walls of chapels, is by right strongly to be censured, seeing that they represent one composition at one level with its landscape and buildings, and then mount to the stage above it and make another, and so vary the point of sight from that of the first painting, and then make a third, and a fourth, in such a way that the work on the one wall shows four points of sight, which is the height of folly on the part of such masters. Now we know that the point of sight is opposite the eye of the spectator of the composition, and if you were to ask me how I should represent the life of a saint when it is divided up in several compositions on the same wall, to this I reply that you ought to set the foreground with its point of sight on a level with the eye of the spectators of the composition, and at this same plane make the chief episode on a large scale, and then by diminishing gradually the figures and buildings upon the various hills and plains, you should represent all the incidents of the story. And on the rest of the wall up to the top you should make trees large as compared with the figures, or angels if these are appropriate to the story, or birds or

clouds or similar things; but otherwise do not put yourself to the trouble for the whole of your work will be wrong. (*MS.* 2038, *Bib. Nat.* 16 *r.*)

OF THE CHOICE OF THE LIGHT WHICH GIVES A GRACE TO FACES

If you have a courtyard which when you so please you can cover over with a linen awning the light will then be excellent. Or when you wish to paint a portrait paint it in bad weather, at the fall of the evening, placing the sitter with his back to one of the walls of the courtyard. Notice in the streets at the fall of the evening the faces of the men and women when it is bad weather, what grace and softness they display. Therefore, O painter, you should have a courtyard fitted up with the walls tinted in black and with the roof projecting forward a little beyond the wall; and the width of it should be ten braccia, and the length twenty braccia, and the height ten braccia; and you should cover it over with the awning when the sun is on it, or else you should make your portrait at the hour of the fall of the evening when it is cloudy or misty, for the light then is perfect.

(*MS.* 2038, *Bib. Nat.* 20 *v.*)

OF THE CHOICE OF BEAUTIFUL FACES

Methinks it is no small grace in a painter to be able to give a pleasing air to his figures, and whoever is not naturally possessed of this grace may acquire it by study, as opportunity offers, in the following manner. Be on the watch to take the best parts of many beautiful faces

of which the beauty is established rather by general repute than by your own judgment, for you may readily deceive yourself by selecting such faces as bear a resemblance to your own, for it would often seem that such similarities please us; and if you were ugly you would not select beautiful faces, and so you would be creating ugly faces like many painters whose types often resemble their master; so therefore choose the beautiful ones as I have said, and fix them in your mind.

(*MS.* 2038, *Bib. Nat.* 27 *r.*)

OF THE ERROR WHICH IS COMMITTED IN JUDGING AS TO THE LIMBS

The painter who has clumsy hands will reproduce the same in his works, and the same thing will happen with every limb unless long study prevents it. Do you then, O painter, take careful note of that part in yourself which is most mis-shapen, and apply yourself by study to remedy this entirely. For if you are brutal, your figures will be the same and devoid of grace, and in like manner every quality that there is within you of good or of evil will be in part revealed in your figures. (*A* 23 *r.*)

A picture or any representation of figures ought to be done in such a way that those who see them may be able with ease to recognise from their attitudes what is passing through their minds. So if you have to represent a man of good repute in the act of speaking, make his gestures accord with the probity of his speech; and similarly if you have to represent a brutal man, make him with fierce movements flinging out his arms

towards his hearer, and the head and chest protruding forward beyond the feet should seem to accompany the hands of the speaker.

Just so a deaf mute who sees two people talking, although being himself deprived of the power of hearing, is none the less able to divine from the movements and gestures of the speakers the subject of their discussion.

I once saw in Florence a man who had become deaf, who could not understand you if you spoke to him loudly, while if you spoke softly without letting the voice utter any sound, he understood you merely from the movement of the lips. Perhaps, however, you will say to me: 'But does not a man who speaks loudly move his lips like one who speaks softly? And since the one moves his lips like the other, will not the one be understood like the other?' As to this I leave the decision to the test of experience. Set some one to speak softly and then [loudly], and watch the lips!

(*C. A.* 139 *r.d.*)

HOW A FIGURE IS NOT WORTHY OF PRAISE UNLESS SUCH ACTION APPEARS IN IT AS SERVES TO EXPRESS THE PASSION OF THE SOUL

That figure is most worthy of praise which by its action best expresses the passion which animates it.

HOW ONE OUGHT TO REPRESENT AN ANGRY FIGURE

An angry figure should be represented seizing some one by the hair and twisting his head down to the ground, with one knee on his ribs, and with the right

arm and fist raised high up; let him have his hair dishevelled, his eyebrows low and knit together, his teeth clenched, the two corners of his mouth arched, and the neck, which is all swollen and extended as he bends over the foe, should be full of furrows.

HOW TO REPRESENT A MAN IN DESPAIR

A man who is in despair you should make turning his knife against himself, and rending his garments with his hands, and one of his hands should be in the act of tearing open his wound. Make him with his feet apart, his legs somewhat bent, and the whole body likewise bending to the ground, and with his hair torn and streaming. (*MS.* 2038, *Bib. Nat.* 29 *v.*)

OF THE WAY TO REPRESENT A NIGHT SCENE

Whatever is entirely deprived of light is all darkness. When such is the condition of night, if you wish to represent a scene therein, you must arrange to introduce a great fire there, and then the things which are nearest to the fire will be more deeply tinged with its colour, for whatever is nearest to the object partakes most fully of its nature; and making the fire of a reddish colour you should represent all the things illuminated by it as being also of a ruddy hue, while those which are farther away from the fire should be dyed more deeply with the black colour of the night. The figures which are between you and the fire will appear dark against the brightness of the flame, for that part of the object which you perceive is coloured by the darkness of the night,

and not by the brightness of the fire; those which are at the sides should be half in shadow and half in ruddy light; and those visible beyond the edge of the flames will all be lit up with ruddy light against a dark background. As for their actions, show those who are near it, making a screen with hands and cloaks as a protection against the unbearable heat, with faces turned away as though on the point of flight; while of those further away you should show a great number pressing their hands upon their eyes, hurt by the intolerable glare.

(*MS.* 2038, *Bib. Nat.* 18 *v.*)

OF HOW TO REPRESENT SOME ONE WHO IS SPEAKING AMONG A GROUP OF PERSONS

When you desire to represent any one speaking among a group of persons you ought to consider first the subject of which he has to treat, and how so to order his actions that they may be in keeping with this subject. That is, if the subject be persuasive the actions should serve this intention; if it be one that needs to be expounded under various heads, the speaker should take a finger of his left hand between two fingers of his right, keeping the two smaller ones closed,[1] and let his face be animated and turned towards the people, with mouth slightly opened, so as to give the effect of speaking. And if he is seated let him seem to be in the act of raising himself more upright, with his head forward; and if you represent him standing, make him leaning forward a little with head and shoulders towards the

[1] MS. has 'serate.' M. Ravaisson-Mollien gives 'searate,' and translates as though it were 'separate.'

populace, whom you should show silent and attentive, and all watching the face of the orator with gestures of admiration. Show the mouths of some of the old men with the corners pulled down in astonishment at what they hear, drawing back the cheeks in many furrows, with their eyebrows raised where they meet, making many wrinkles on their foreheads; and show some sitting with the fingers of their hands locked together and clasping their weary knees, and others—decrepit old men—with one knee crossed over the other, and one hand resting upon it which serves as a cup for the other elbow, while the other hand supports the bearded chin. (*MS.* 2038, *Bib. Nat.* 21 *r.*)

[NOTES FOR 'THE LAST SUPPER']

One who was drinking has left the glass where it was and turned his head towards the speaker. Another twists the fingers of his hands together and turns with set brows to his companion. Another with his hands spread open displays their palms and shrugs his shoulders up towards his ears and gapes in astonishment. Another is speaking in his neighbour's ear, and he who listens turns towards him and gives him hearing, holding in one hand a knife, and in the other the bread half cut through by the knife. Another, as he turns round holding a knife in his hand, has upset with his hand a glass which is upon the table.

Another rests his hands upon the table and watches. Another blows out his mouth. Another bends forward to see the speaker and makes a shade for his eyes with his hand. Another leans back behind the one who is

bending forward, and sees the speaker between the wall and him who bends forward.

(*S. K. M. ii.*, 62 *v. and* 63 *r.*)

HOW TO REPRESENT A TEMPEST

If you wish to represent a tempest properly, consider and set down exactly what are the results when the wind blowing over the face of the sea and of the land lifts and carries with it everything that is not immovable in the general mass. And in order properly to represent this tempest, you must first of all show the clouds, riven and torn, swept along in the path of the wind, together with storms of sand blown up from the sea shores, and branches and leaves caught up by the irresistible fury of the gale and scattered through the air, and with them many other things of light weight. The trees and shrubs should be bent to the ground, as though showing their desire to follow the direction of the wind, with their branches twisted out of their natural growth and their leaves tossed and inverted. Of the men who are there, some should have fallen and be lying wrapped round by their garments and almost indistinguishable on account of the dust, and those who are left standing should be behind some tree with their arms thrown round it to prevent the wind from dragging them away; others should be shown crouching on the ground, their hands over their eyes because of the dust, their garments and hair streaming in the wind. Let the sea be wild and tempestuous, and between the crests of its waves it should be covered with eddying foam, and the wind should carry the finer spray through the stormy air after the manner of a thick and

all-enveloping mist. Of the ships that are there, some you should show with sail rent and the shreds of it flapping in the air in company with the broken halyards, and some of the masts broken and gone by the board, and the vessel itself lying disabled and broken by the fury of the waves, with some of the crew shrieking and clinging to the fragments of the wreck. You should show the clouds, driven by the impetuous winds, hurled against the high mountain tops, and there wreathing and eddying like waves that beat upon the rocks; the very air should strike terror through the murky darkness occasioned therein by the dust and mist and thick clouds.

(*MS.* 2038, *Bib. Nat.* 21 *r.*)

THE WAY TO REPRESENT A BATTLE

Show first the smoke of the artillery mingled in the air with the dust stirred up by the movement of the horses and of the combatants. This process you should express as follows: the dust, since it is made up of earth and has weight, although by reason of its fineness it may easily rise and mingle with the air, will nevertheless readily fall down again, and the greatest height will be attained by such part of it as is the finest, and this will in consequence be the least visible and will seem almost the colour of the air itself.

The smoke which is mingled with the dust-laden air will as it rises to a certain height have more and more the appearance of a dark cloud, at the summit of which the smoke will be more distinctly visible than the dust. The smoke will assume a bluish tinge, and the dust will

keep its natural colour. From the side whence the light comes this mixture of air and smoke and dust will seem far brighter than on the opposite side.

As for the combatants, the more they are in the midst of this turmoil the less they will be visible, and the less will be the contrast between their lights and shadows.

You should give a ruddy glow to the faces and the figures and the air around them, and to the gunners and those near to them, and this glow should grow fainter as it is further away from its cause. The figures which are between you and the light, if far away, will appear dark against a light background, and the nearer their limbs are to the ground the less will they be visible, for there the dust is greater and thicker. And if you make horses galloping away from the throng make little clouds of dust as far distant one from another as is the space between the strides made by the horse, and that cloud which is further away from the horse should be the least visible, for it should be high and spread out and thin, while that which is nearer should be more conspicuous and smaller and more compact.

Let the air be full of arrows going in various directions, some mounting upwards, others falling, others flying horizontally, and let the balls shot from the guns have a train of smoke following their course. Show the figures in the foreground covered with dust on their hair and eyebrows and such other level parts as afford the dust a space to lodge.

Make the conquerors running, with their hair and other light things streaming in the wind, and with brows bent down; and they should be thrusting forward

opposite limbs, that is, if a man advances the right foot the left arm should also come forward. If you represent any one fallen you should show the mark where he has been dragged through the dust, which has become changed to blood-stained mire, and round about in the half-liquid earth you should show the marks of the tramping of men and horses who have passed over it. Make a horse dragging the dead body of his master, and leaving behind him in the dust and mud the track of where the body was dragged along.

Make the beaten and conquered pallid, with brows raised and knit together, and let the skin above the brows be all full of lines of pain; at the sides of the nose show the furrows going in an arch from the nostrils and ending where the eye begins, and show the dilation of the nostrils which is the cause of these lines; and let the lips be arched displaying the upper row of teeth, and let the teeth be parted after the manner of such as cry in lamentation. Show some one using his hand as a shield for his terrified eyes, turning the palm of it towards the enemy, and having the other resting on the ground to support the weight of his body; let others be crying out with their mouths wide open, and fleeing away. Put all sorts of arms lying between the feet of the combatants, such as broken shields, lances, broken swords, and other things like these. Make the dead, some half buried in dust, others with the dust all mingled with the oozing blood and changing into crimson mud; and let the line of the blood be discerned by its colour, flowing in a sinuous stream from the corpse to the dust. Show others in the death agony grinding their teeth and

rolling their eyes, with clenched fists grinding against their bodies, and with legs distorted. Then you might show one, disarmed and struck down by the enemy, turning on him with teeth and nails to take fierce and inhuman vengeance; and let a riderless horse be seen galloping with mane streaming in the wind, charging among the enemy and doing them great mischief with his heels. You may see there one of the combatants maimed and fallen on the ground protecting himself with his shield, and the enemy bending down over him and striving to give him the fatal stroke; there might also be seen many men fallen in a heap on top of a dead horse; and you should show some of the victors leaving the combat and retiring apart from the crowd, and with both hands wiping away from eyes and cheeks the thick layer of mud caused by the smarting of their eyes from the dust.[1] And the squadrons of the reserves should be seen standing full of hope but cautious, with eyebrows raised, and shading their eyes with their hands, peering into the thick, heavy mist in readiness for the commands of their captain; and so too the captain with his staff raised, hurrying to the reserves and pointing out to them the quarter of the field where they are needed; and you should show a river, within which horses are galloping, stirring the water all around with a heaving mass of waves and foam and broken water, leaping high into the air and over the legs and bodies of the horses; but see that you make no level spot of ground that is not trampled over with blood.

(*MS.* 2038, *Bib. Nat.* 31 *r. and* 30 *v.*)

[1] MS. has 'per lamor della polvere.'

REPRESENTATION OF A DELUGE

The air was dark from the heavy rain which was falling slantwise bent by the cross current of the winds and formed itself in waves in the air, like those one sees formed by the dust, the only difference being that these drifts were furrowed by the lines made by the drops of the falling water. It was tinged by the colour of the fire produced by the thunderbolts wherewith the clouds were rent and torn asunder, the flashes from which smote and tore open the vast waters of the flooded valleys, and as these lay open there were revealed in their depths[1] the bowed summits of the trees.

Neptune might be seen with his trident in the midst of the waters, and Eolus with his winds should be shown entangling the floating trees which had been uprooted and were mingled with the mighty waves.

The horizon and the whole firmament was overcast and lurid with the flashings of the incessant lightning. Men and birds might be seen crowded together upon the tall trees which over-topped the swollen waters forming hills which surround the great abysses. (*G* 6 *v.*)

OF A DELUGE AND THE REPRESENTATION OF IT IN PAINTING

Let the dark, gloomy air be seen beaten by the rush of opposing winds wreathed in perpetual rain mingled with hail,[2] and bearing hither and thither a vast network

[1] Dr. Richter reads 'vertici.' I have followed M. Ravaisson-Mollien in reading 'ventri.' The MS. has 'vertri.'

[2] MS. 'gravza.' I have followed Dr. Richter's suggestion 'gragnuola.'

of the torn branches of trees mixed together with an infinite number of leaves. All around let there be seen ancient trees uprooted and torn in pieces by the fury of the winds. You should show how fragments of mountains which have been already stripped bare by the rushing torrents fall headlong into these very torrents and choke up the valleys, until the pent-up rivers rise in flood and cover the wide plains and their inhabitants. Again there might be seen huddled together on the tops of many of the mountains many different sorts of animals, terrified and subdued at last to a state of tameness, in company with men and women who had fled there with their children. And the fields which were covered with water had their waves covered over in great part with tables, bedsteads, boats and various other kinds of rafts improvised through necessity and fear of death, upon which were men and women with their children, massed together and uttering various cries and lamentations, dismayed by the fury of the winds which were causing the waters to roll over and over in mighty hurricane, bearing with them the bodies of the drowned ; and there was no object that floated on the water but was covered with various different animals who had made truce and stood huddled together in terror, among them being wolves, foxes, snakes, and creatures of every kind, fugitives from death. And all the waves that beat against their sides were striking them with repeated blows from the various bodies of the drowned, and the blows were killing those in whom life remained.

Some groups of men you might have seen with arms in their hands defending the tiny footholds that remained to

them from the lions and wolves and beasts of prey which sought safety there. Ah, what dreadful tumults one heard resounding through the gloomy air, smitten by the fury of the thunder and the lightning it flashed forth, which sped through it, bearing ruin, striking down whatever withstood its course! Ah, how many might you have seen stopping their ears with their hands in order to shut out the loud uproar caused through the darkened air by the fury of the winds mingled together with the rain, the thunder of the heavens and the raging of the thunderbolts! Others were not content to shut their eyes, but placing their hands over them, one above the other, would cover them more tightly in order not to see the pitiless slaughter made of the human race by the wrath of God.

Ah me, how many lamentations! How many in their terror flung themselves down from the rocks! You might have seen huge branches of the giant oaks laden with men borne along through the air by the fury of the impetuous winds. How many boats were capsized and lying, some whole, others broken in pieces, on the top of men struggling to escape with acts and gestures of despair which foretold an awful death. Others with frenzied acts were taking their own lives, in despair of ever being able to endure such anguish; some of these were flinging themselves down from the lofty rocks, others strangled themselves with their own hands; some seized hold of their own children, and with mighty violence[1] slew them at one blow; some turned their arms against

[1] MS. 'inpeto'—'impeto.' Richter reads MS. as 'rapito,' and gives in text 'rapidità.'

themselves to wound and slay ; others falling upon their knees were commending themselves to God.

Alas, how many mothers were bewailing their drowned sons, holding them upon their knees, lifting up open arms to heaven, and with divers cries and shrieks declaiming against the anger of the gods ! Others with hands clenched and fingers locked together gnawed and devoured them with bites that ran blood, crouching down so that their breasts touched their knees in their intense and intolerable agony.

Herds of animals, such as horses, oxen, goats, sheep, were to be seen already hemmed in by the waters and left isolated upon the high peaks of the mountains, all huddling together, and those in the middle climbing to the top and treading on the others, and waging fierce battles with each other, and many of them dying from want of food.

And the birds had already begun to settle upon men and other animals, no longer finding any land left unsubmerged which was not covered with living creatures. Already had hunger the minister of death taken away their life from the greater number of the animals, when the dead bodies already becoming lighter began to rise from out the bottom of the deep waters and emerged to the surface among the contending waves ; and there lay beating one against another, and as balls puffed up with wind rebound back from the spot where they strike, these fell back and lay upon the other dead bodies. And above these horrors the atmosphere was seen covered with murky clouds that were rent by the jagged course of the raging thunderbolts of heaven which flashed light hither and thither amid the obscurity of the darkness.

The velocity of the air is seen by the movement of the dust stirred by the running of a horse ; and it moves as swiftly to fill up the void left in the air which had enclosed the horse as is the speed of the horse in passing away from the aforesaid space of air.

But it will perhaps seem to you that you have cause to censure me for having represented the different courses taken in the air by the movement of the wind, whereas the wind is not of itself visible in the air ; to this I reply that it is not the movement of the wind itself but the movement of the things carried by it which alone is visible in the air.

THE DIVISIONS

Darkness, wind, tempest at sea, deluge of water, woods on fire, rain, thunderbolts from the sky, earthquakes and destruction of mountains, levelling of cities.

Whirlwinds which carry water and branches of trees and men through the air.

Branches torn away by the winds crashing together at the meeting of the winds, with people on the top of them.

Trees broken off laden with people.

Ships broken in pieces dashed upon the rocks.

Hail, thunderbolts, whirlwinds.

Herds of cattle.

People on trees which cannot bear them: trees and rocks, towers, hills crowded with people, boats, tables,

troughs and other contrivances for floating,—hills covered with men and women and animals, with lightnings from the clouds which illumine the whole scene.

(*Windsor MSS. Études et dessins sur l'atmosphere* [*Rouveyre*] 17 *v.*)

DESCRIPTION OF THE DELUGE

First of all let there be represented the summit of a rugged mountain with certain of the valleys that surround its base, and on its sides let the surface of the soil be seen slipping down together with the tiny roots of the small shrubs, and leaving bare a great part of the surrounding rocks. Sweeping down in devastation from these precipices, let it pursue its headlong course, striking and laying bare the twisted and gnarled roots of the great trees and overturning them in ruin. And the mountains becoming bare should reveal the deep fissures made in them by the ancient earthquakes; and let the bases of the mountains be in great part covered over and clad with the débris of the shrubs which have fallen headlong from the sides of the lofty peaks of the said mountains, and let these be mingled together with mud, roots, branches of trees, with various kinds of leaves thrust in among the mud and earth and stones. And let the fragments of some of the mountains have fallen down into the depth of one of the valleys, and there form a barrier to the swollen waters of its river, which having already burst the barrier rushes on with immense waves, the greatest of which are striking and laying in ruin the walls of the cities and farms of the valley. And from the ruins of the lofty buildings of the aforesaid cities let there rise a great quantity of dust mounting up in the

air with the appearance of smoke or of wreathed clouds that battle against the descending rain.

But the swollen waters should be coursing round the pool which confines them, and striking against various obstacles with whirling eddies, leaping up into the air in turbid foam, and then falling back and causing the water where they strike to be dashed up into the air; and the circling waves which recede from the point of contact are impelled by their impetus right across the course of the other circling waves which move in an opposite direction to them, and after striking against these they leap up into the air without becoming detached from their base. And where the water issues forth from the said pool, the spent waves are seen spreading out towards the outlet; after which, falling or descending through the air, this water acquires weight and impetus; and then piercing the water where it strikes, it tears it apart and dives down in fury to reach its depth, and then recoiling it springs back again towards the surface of the lake accompanied by the air which has been submerged with it, and this remains in the slimy foam[1] mingled with the driftwood and other things lighter than the water, and around these again are formed the beginnings of the waves, which increase the more in circumference as they acquire more movement; and this movement makes them lower in proportion as they acquire a wider base, and therefore they become almost imperceptible as they die away. But if the waves rebound against various obstacles then they leap back and

[1] Richter's transcript (§ 609) is 'vissci cholla' and he reads 'nella *uscita colla* sciuma.' The MS. has I think 'visscichosa,' which I have taken as a variant of 'vischiosa.'

oppose the approach of the other waves, following the same law of development in their curve as they have already shown in their original movement. The rain as it falls from the clouds is of the same colour as these clouds, that is on its shaded side, unless, however, the rays of the sun should penetrate there, for if this were so the rain would appear less dark than the cloud. And if the great masses of the débris of huge mountains or of large buildings strike in their fall the mighty lakes of the waters, then a vast quantity of water will rebound in the air, and its course will be in an opposite direction to that of the substance which struck the water, that is to say the angle of reflection will be equal to the angle of incidence.

Of the objects borne along by the current of the waters that will be at a greater distance from the two opposite banks which is heavier or of larger bulk. The eddies of the waters revolve most swiftly in those parts which are nearest to their centre. The crests of the waves of the sea fall forward to their base, beating and rubbing themselves against the smooth particles which form their face ; and by this friction the water as it falls is ground up in tiny particles,[1] and becomes changed to thick mist and is mingled in the currents of the winds in the manner of wreathing smoke or winding clouds, and at last rises up in the air and becomes changed into clouds. But the rain which falls through the air being beaten upon and driven by the current of the winds becomes rare or dense according to the rarity or density of these winds, and by this means there is produced

[1] MS. 'e ttal confreghatione trita in minute partichule la dissciente acqua.'

throughout the air a flood of transparent clouds which is formed by the aforesaid rain and becomes visible in it by means of the lines made by the fall of the rain which is near to the eye of the spectator.[1] The waves of the sea that beats against the shelving base of the mountains which confine it, rush[2] foaming in speed up to the ridge of these same hills, and in turning back meet the onset of the succeeding wave, and after loud roaring return in a mighty flood to the sea from whence they came. A great number of the inhabitants, men and different animals, may be seen driven by the rising of the deluge up towards the summits of the hills which border on the said waters.

Waves of the sea at Piombino all of foaming water.

Of the water that leaps up—(of the place where the great masses fall and strike the waters)[3]—of the winds of Piombino.

Eddies of winds and of rain with branches and trees mingled with the air.

The emptying the boats of the rain water.

(*Windsor MSS. Études et dessins sur l'atmosphère* [*Rouveyre*] 17 *r.*)

[1] MS. ce p(er) quessto si gienera infrallaria vna innondatione di trasspareti *nuvoli la quale effacta dalla p(r)edetta pioggia e inquassta si fa manifessta mediante i liniamēti* fatti dal dissciēso della pioggia che e vicina all ochio che la vede.' The words printed in Italics are wanting in the text as given by Dr. Richter (§ 609).

[2] Dr. Richter reads 'saranno' (for MS. 'sarrano'), but text is I think 'scorrano,' presumably for 'scorrono.'

[3] The sentence within brackets is crossed through in the MS.

III. PERSPECTIVE, AND LIGHT AND SHADE

Among the various studies of natural processes that of light gives most pleasure to those who contemplate it; and among the noteworthy characteristics of mathematical science the certainty of its demonstrations is what operates most powerfully to elevate the minds of its investigators. Perspective therefore is to be preferred to all the formularies and systems of the schoolmen, for in its province the complex beam of light is made to show the stages of its development, wherein is found the glory not only of mathematical but also of physical science, adorned as it is with the flowers of both. And whereas its propositions have been expanded with much circumlocution I will epitomise them with conclusive brevity, introducing, however, illustrations drawn either from nature or from mathematical science according to the nature of the subject, and sometimes deducing the results from the causes and at other times the causes from the results; adding also to my conclusions some which are not contained in these, but which nevertheless are to be inferred from them; even as the Lord who is the Light of all things shall vouchsafe to reveal to me who seek to interpret this light,—and consequently I will divide the present work into three parts.

(*C. A.* 203 *r. a.*)

PREAMBLE TO PERSPECTIVE—CONCERNING THE FUNCTION OF THE EYE

Consider now, O Reader, what trust can we place in the ancients who have set out to define the nature of the soul and of life,—things incapable of proof,—whilst

those things which by experience may always be clearly known and proved have for so many centuries either remained unknown or have been wrongly interpreted.

The eye which thus clearly offers proof of its functions has even down to our own times been defined by countless writers in one way, but I find by experience that it acts in another. (*C. A.* 119 *v. a.*)

Perspective is the bridle and rudder of painting.
(*MS.* 2038, *Bib. Nat.* 13 *r.*)

Perspective is a rational demonstration whereby experience confirms how all things transmit their images to the eye by pyramidal lines. By pyramidal lines I mean those which start from the extremities of the surface of bodies and by gradually converging from a distance arrive at the same point; the said point being, as I shall show, in this particular case located in the eye, which is the universal judge of all objects. I call a point that which cannot be divided up into any parts; and as this point which is situated in the eye is indivisible no body can be seen by the eye which is not greater than this point, and this being the case it is necessary that the lines which extend from the object to the point should be pyramidal. And if any one should wish to prove that the faculty of sight does not belong to this point but rather to that black spot which is seen in the centre of the pupil, one might reply to him that a small object never could diminish at any distance, as for example a grain of millet or panic-seed or other similar thing, and that this thing which was greater than the said point could never be entirely seen. (*A.* 10 *r.*)

The body of the atmosphere is full of an infinite number of the pyramids composed of radiating straight lines which are caused by the boundaries of the surfaces of the bodies in shadow that are found there, and the further they are away from the object which produces them the more their angle becomes acute. And although they intersect and interlace in their passage, nevertheless they do not become confused with each other but proceed with divergent course, spreading themselves out and becoming diffused through all the surrounding air. And they are of equal power among themselves, all equal to each, and each equal to all, and by means of them are transmitted the images of the objects, and these are transmitted all in all, and all in each part; and each pyramid receives of itself in each of its smallest parts the whole form of the object which produces it. (*MS.* 2038, *Bib. Nat.* 6 *v.*)

OF THE ERROR MADE BY THOSE WHO PRACTISE WITHOUT SCIENCE

Those who are enamoured of practice without science are like a pilot who goes into a ship without rudder or compass and never has any certainty where he is going.

Practice should always be based upon a sound knowledge of theory, of which perspective is the guide and gateway, and without it nothing can be done well in any kind of painting. (*G* 8 *r.*)

PERSPECTIVE

Of things of equal size that which is further away from the eye will appear of less bulk. (*S. K. M. ii.* 15 *v.*)

BRAMBLE
(*Rubus Fruticosus*)

Face p. 212

OF LINEAR PERSPECTIVE

Linear perspective has to do with the function of the lines of sight, proving by measurement how much smaller is the second object than the first and the third than the second, and so on continually until the limit of things seen. I find by experience that if the second object is as far distant from the first as the first is from your eye, although as between themselves they may be of equal size, the second will seem half as small again as the first; and if the third object is equal in size to the second, and it is as far-beyond the second as the second is from the first,[1] it will appear half the size of the second; and thus by successive degrees at equal distances the objects will be continually lessened by half, the second being half the first,—provided that the intervening space does not amount to as much as twenty braccia; for at the distance of twenty braccia a figure resembling yours will lose four-fifths of its size, and at a distance of forty braccia it will lose nine-tenths, and nineteen-twentieths at sixty braccia, and so by degrees it will continue to diminish when the plane of the picture is twice your own height away from you, for if the distance only equals your own height there is a great difference between the first braccia and the second.

(*MS.* 2038, *Bib. Nat.* 23 *r.*)

OF AERIAL PERSPECTIVE

There is another kind of perspective which I call aerial, because by the difference in the atmosphere one

[1] MS. has 'third.'

is able to distinguish the various distances of different buildings when their bases appear to end on a single line, for this would be the appearance presented by a group of buildings on the far side of a wall, all of which as seen above the top of the wall look to be the same size; and if in painting you wish to make one seem further away than another you must make the atmosphere somewhat heavy. You know that in an atmosphere of uniform density the most distant things seen through it, such as the mountains, in consequence of the great quantity of atmosphere which is between your eye and them, will appear blue, almost of the same colour as the atmosphere when the sun is in the east. Therefore you should make the building which is nearest above the wall of its natural colour, and that which is more distant make less defined and bluer; and one which you wish should seem as far away again make of double the depth of blue, and one you desire should seem five times as far away make five times as blue. And as a consequence of this rule it will come about that the buildings which above a given line appear to be of the same size will be plainly distinguished as to which are the more distant and which larger than the others.

(*MS.* 2038, *Bib. Nat.* 25 *v.*)

OF ORDINARY PERSPECTIVE

An object of uniform thickness and colour seen against a background of various colours will appear not to be of uniform thickness.

And if an object of uniform thickness and of various

colours is seen against a background of uniform colour the object will seem of a varying thickness.

And in proportion as the colours of the background, or of the object seen against the background, have more variety, the more will their thickness seem to vary, although the objects seen against the background may be of equal thickness. (*I* 17 *v.*)

A dark object seen against a light background will seem smaller than it is.

A light object will appear greater in size when it is seen against a background that is darker in colour. (*I* 18 *r.*)

THE PERSPECTIVE OF THE DISAPPEARANCE OF THE OUTLINES OF OPAQUE BODIES

If the true outlines of opaque bodies become indistinguishable at any short distance they will be still more invisible at great distances; and since it is by the outlines that the true shape of each opaque body becomes known, whenever because of distance we lack the perception of the whole we shall lack yet more the perception of its parts and outlines. (*E* 80 *r.*)

OF THE REQUISITES OF PAINTING

The first requisite of painting is that the bodies which it represents should appear in relief, and that the scenes which surround them with effects of distance should seem to enter into the plane in which the picture is produced by means of the three parts of perspective, namely the diminution in the distinctness of the form of bodies, the diminution in their size, and the diminution

in their colour. Of these three divisions of perspective the first has its origin in the eye, the two others are derived from the atmosphere that is interposed between the eye and the objects which the eye beholds.

The second requisite of painting is that the actions should be appropriate and have a variety in the figures so that the men may not all look as though they were brothers. (*E* 79 *v.*)

PERSPECTIVE

The air is full of an infinite number of images of the things which are distributed through it, and all of these are represented in all, all in one, and all in each. Consequently it so happens that if two mirrors be placed so as to be exactly facing each other, the first will be reflected in the second and the second in the first. Now the first being reflected in the second carries to it its own image together with all the images which are represented in it, among these being the image of the second mirror; and so they continue from image to image on to infinity, in such a way that each mirror has an infinite number of mirrors within it, each smaller than the last, and one inside another.

By this example, therefore, it is clearly proved that each thing transmits the image of [itself] to all those places where the thing itself is visible, and so conversely this object is able to receive into itself all the images of the things which are in front of it.

Consequently the eye transmits its own image through the air to all the objects which are in front of it, and receives them into itself, that is on its surface, whence

the understanding takes them and considers them, and such as it finds pleasing these it commits to the memory.

So I hold that the invisible powers of the images in the eyes may project themselves forth to the object as do the images of the object to the eye.

An instance of how the images of all things are spread through the air may be seen in a number of mirrors placed in a circle, and they will then reflect each other for an infinite number of times, for as the image of one reaches another it rebounds back to its source, and then becoming less rebounds yet again to the object, and then returns, and so continues for an infinite number of times.

If at night you place a light between two flat mirrors which are a cubit's space apart, you will see in each of these mirrors an infinite number of lights one smaller than another in succession.

If at night you place a light between the walls of a [room], every part of these walls will become tinged by the images of this light, and all those parts which are exposed to the light will likewise be directly lit by it; that is when there is no obstacle between them to interrupt the transmission of the images.

This same example is even more apparent in the transmission of solar rays, which all [pass] through all objects, and consequently into each minutest part of each object, and each ray of itself conveys to its object the image of its source.

That each body alone of itself fills the whole surrounding air with its images, and that this same air is [able] at the same time to receive into itself the images

of the countless other bodies which are within it is clearly shown by these instances, and each body is seen in its entirety throughout the whole of the said atmosphere and each in each minutest part of the same, and all throughout the whole of it and all in each minutest part; each in all, and all in every part. (*C. A.* 138 *r. b.*)

OF PAINTING AND PERSPECTIVE

There are three divisions of perspective as employed in painting. Of these the first relates to the diminution in the volume of opaque bodies; the second treats of the diminution and disappearance of the outlines of these opaque bodies; the third is of their diminution and loss of colour when at a great distance.

OF THE PERSPECTIVE OF THE DIMINUTION OF OPAQUE BODIES

Among opaque bodies of equal magnitude the diminution apparent in their size will vary according to their distance from the eye which sees them; but it will be in inverse proportion, for at the greater distance the opaque body appears less, and at a less distance this body will appear greater, and on this is founded linear perspective. And show secondly how every object at a great distance loses first that portion of itself which is the thinnest. Thus with a horse, it would lose the legs sooner than the head because the legs are thinner than the head, and it would lose the neck before the trunk for the same reason. It follows

therefore that the part of the horse which the eye will be able last to discern will be the trunk, retaining still its oval form, but rather approximating to the shape of a cylinder, and it will lose its thickness sooner than its length from the second conclusion aforesaid. If the eye is immovable the perspective terminates its distance in a point; but if the eye moves in a straight line the perspective ends in a line, because it is proved that the line is produced by the movement of the point, and our sight is fixed upon the point, and consequently it follows that as the sight moves the point moves, and as the point moves the line is produced. (*E* 80 *v.*)

In every figure placed at a great distance you lose first the knowledge of its most minute parts and preserve to the last that of the larger parts, losing, however, the perception of all their extremities, and they become oval or spherical in shape, and their boundaries are indistinct. (*G* 53 *v.*)

Having, as I think, sufficiently treated of the natures and different characteristics of primary and derived shadows and the manner of their incidence, it seems to me that the time has now come to explain the different results upon the various surfaces which are touched by these shadows.

SHADOW IS THE WITHHOLDING OF LIGHT

It seems to me that the shadows are of supreme importance in perspective, seeing that without them opaque and solid bodies will be indistinct, both as to

what lies within their boundaries and also as to their boundaries themselves, unless these are seen against a background differing in colour to that of the substance; and consequently in the first proposition I treat of shadows, and say in this connection that every opaque body is surrounded and has its surface clothed with shadows and lights, and to this I devote the first book. Moreover these shadows are in themselves of varying degrees of darkness because they are caused by the absence of a variable quantity of luminous rays; and these I call primary shadows, because they are the first shadows and so form a covering to the bodies to which they attach themselves, and to this I shall devote the second book. From these primary shadows there issue certain dark rays which are diffused throughout the air and vary in intensity according to the varieties of the primary shadows from which they are derived; and consequently I call these shadows derived shadows, because they have their origin in other shadows; and of this I will make the third book. Moreover these derived shadows in striking upon anything create as many different effects as are the different places where they strike; and of this I will make the fourth book. And since where the derived shadow strikes, it is always surrounded by the striking of the luminous rays, it leaps back with these in a reflex stream towards its source and meets the primary shadow, and mingles with and becomes changed into it, altering thereby somewhat of its nature; and to this I will devote the fifth book. In addition to this I will make the sixth book to contain an investigation of the many different varieties of the

rebound of the reflected rays which will modify the primary shadow by as many different colours as there are different points from whence these luminous reflected rays proceed. Further, I will make the seventh division treat of the various distances that may exist between the point of striking of each reflected ray and the point from whence it proceeds, and of the various different shades of colour which it acquires in striking against opaque bodies. (*C. A.* 250, *r. a.*)

OF PAINTING

Shadows and lights are observed by the eye under three aspects. One of these is when the eye and the light are both on the same side of the body which is seen; the second is when the eye is in front of the object and the light behind it; and the third is that in which the eye is in front of the object and the light at the side, in such a way that when the line which extends from the object to the eye meets that which extends from the object to the light, they will at their junction[1] form a right angle. (*K* 105 [25] *v.*)

OF SHADOW

Where the shadow is bounded by light, note carefully where it is lighter or darker, and where it is more or less indistinct towards the light; and above all I would remind you that in youthful figures you should not make the shadows end like stone, for the flesh retains a slight transparency, as may be observed by looking at

[1] MS. cõgnũtiõ, and so Dr. Richter. M. Ravaisson-Mollien has 'cognition.'

a hand held between the eye and the sun, when it is seen to flush red and to be of a luminous transparency. And let the part which is brightest in colour be between the lights and the shadows. And if you wish to see what depth of shadow is needed for the flesh, cast a shadow over it with your finger, and according as you wish it to be lighter or darker, hold your finger nearer or farther away from the picture, and then copy this shadow. (*MS.* 2038, *Bib. Nat.* 31 *v.*)

HOW SMALL FIGURES OUGHT CONSEQUENTLY TO BE LEFT UNFINISHED

I say that when objects appear of minute size, it is due to the said objects being at a distance from the eye; and when this is the case, there must of necessity be a considerable quantity of atmosphere between the eye and the object, and this atmosphere interferes with the distinctness of the form of the objects, and consequently the minute details of these bodies will become indistinguishable and unrecognisable. Therefore, O painter, you should make your lesser figures only suggested, and not highly finished; for if you do otherwise, you will produce effects contrary to those of nature, your mistress.

The object is small because of the great space which exists between the eye and it. This great space contains within itself a great quantity of atmosphere; and this atmosphere forms of itself a dense body which interposes and shuts out from the eye the minute details of the objects. (*MS.* 2038, *Bib. Nat.* 31 *v.*)

PAINTING

Among shadows of equal strength that which is nearest to the eye will seem of least density.

(*MS.* 2038, *Bib. Nat.* 9 *v.*)

The derived shadow is stronger in proportion as it is nearer to its source. (*K* 111 [31] *v.*)

Primary and derived shadow is deeper when it is caused by the light of the candle than by that of the atmosphere.

(*Tr. Tav.* 24 *a.*)

OF PAINTING

Shadows which you see with difficulty, and whose boundaries you cannot define,—but which you only apprehend and reproduce in your work with some hesitation of judgment—these you should not represent as finished or sharply defined, for the result would be that your work would seem wooden. (*MS.* 2038, *Bib. Nat.* 14 *v.*)

WHY FACES AT A DISTANCE APPEAR DARK

We see clearly that all the images of the visible things both large and small which serve us as objects enter to the sense through the tiny pupil of the eye. If, then, through so small an entrance there passes the image of the immensity of the sky and of the earth, the face of man—being almost nothing amid such vast images of things, because of the distance which diminishes it—occupies so little of the pupil as to remain indistinguishable; and having to pass from the outer surface to the seat of the sense through a dark medium, that is,

through the hollow cells which appear dark, this image when not of a strong colour is affected by the darkness through which it passes, and on reaching the seat of the sense it appears dark. No other reason can be advanced to account for the blackness of this point in the pupil; and since it is filled with a moisture transparent like the air, it acts like a hole made in a board; and when looked into it appears black, and the objects seen in the air, whether light or dark, become indistinct in the darkness.

OF SHADOWS IN THE FAR DISTANCE

Shadows become lost in the far distance, because the vast expanse of luminous atmosphere which lies between the eye and the object seen suffuses the shadows of the object with its own colour.

WHY A MAN SEEN AT A CERTAIN DISTANCE CANNOT BE RECOGNISED

Diminishing perspective shows us that in proportion as an object is further away the smaller it becomes. And if you look at a man who is at the distance of a bowshot away from you and put the eye of a small needle close to your eye you will be able through this to see the images of many men transmitted to the eye, and these will all be contained at one and the same time within the eye of the said needle. If then the image of a man who is distant from you the space of a bowshot is so transmitted to your eye as to occupy only a small part of the eye of a needle, how should you be able in so small a figure to distinguish or discern the nose or

mouth or any detail of the body? And not seeing these you cannot recognise the man since he does not show you the features which cause men to differ in appearance. (*MS.* 2038, *Bib. Nat.* 20 *v.*)

OF PAINTING

The true knowledge of the form of an object becomes gradually lost in proportion as distance decreases its size. (*C. A.* 176 *v. b.*)

WHY OF TWO OBJECTS OF EQUAL SIZE THE PAINTED ONE WILL LOOK LARGER THAN THAT IN RELIEF

This proposition is not so easy to expound as many others, but I will nevertheless attempt to prove it, if not completely, then in part. Diminishing perspective demonstrates by reason that objects diminish in proportion as they are farther away from the eye, and this theory is entirely confirmed by experience. Now the lines of sight which are between the object and the eye when they reach the surface of the painting are all intersected at a uniform boundary; while the lines which pass from the eye to the piece of sculpture have different boundaries and are of varying lengths. The line which is the longest extends to a limb which is farther away than the rest, and consequently this limb appears smaller; and there are many lines longer than others, for the reason that there are many small parts one farther away than another, and being farther away these of necessity appear smaller, and by appearing smaller they effect a corresponding decrease in the whole mass

of the object. But this does not happen in the painting, because as the lines of sight end at the same distance it follows that they do not undergo diminution, and as the parts are not themselves diminished they do not lessen the whole mass of the object, and consequently the diminution is not perceptible in the painting as it is in sculpture. (*MS.* 2038, *Bib. Nat.* 19 *r.*)

OF REFLECTION

Reflections are caused by bodies of a bright nature and of a smooth and half opaque surface, which when struck by the light drive it back again to the first object like the rebound of a ball.

OF WHERE THERE CANNOT BE LUMINOUS REFLECTION

All solid bodies have their surfaces covered by various degrees of light and shadow. The lights are of two kinds; the one is called original, the other derived. Original I call that which proceeds from the flame of the fire, or from the light of the sun, or of the atmosphere. Derived light is the light reflected. But to return to the promised definition I say that there is no luminous reflection on the side of the body which is turned towards objects in shadow such as shaded scenes, meadows with grasses of varying height, green or bare woods—for these, although the part of each branch turned to the original light is imbued with the attributes of this light, have nevertheless so many shadows cast by each branch separately, and so many shadows cast by one branch on another that in the whole mass there results

such a depth of shadow that the light is as nothing; hence objects such as these cannot throw any reflected light upon bodies opposite to them.

(*MS.* 2038, *Bib. Nat.* 14 *v.*)

That place will be most luminous which is farthest away from mountains. (*H* 68 [20] *r.*)

PERSPECTIVE

The shadows or reflections of things seen in moving water, that is to say with tiny waves, will always be greater than the object outside the water which causes them. (*H* 76 [28] *v.*)

The atmosphere is blue because of the darkness which is above it, for black and white together make blue.

(*H* 77 [29] *v.*)

The part of the cloud which is nearest to the eye will seem swifter than that which is higher; and for this reason they often appear to be moving in contrary directions, one to the other. (*H* 89 [41] *r.*)

OF PAINTING

The high lights or the lustre of any particular object will not be situated in the centre of the illuminated part, but will make as many changes of position as the eye that beholds it. (*H* 90 [42] *v.*)

HOW WHITE BODIES OUGHT TO BE REPRESENTED

When you are representing a white body surrounded by ample space, since the white has no colour in itself it is tinged and in part transformed by the colour of what

is set over against it. If you are looking at a woman dressed in white in the midst of a landscape the side of her that is exposed to the sun will be so dazzling in colour that parts of it, like the sun itself, will cause pain to the sight, and as for the side exposed to the atmosphere —which is luminous because of the rays of the sun being interwoven with it and penetrating it—since this atmosphere is itself blue, the side of the woman which is exposed to it will appear steeped in blue. If the surface of the ground near to her be meadows, and the woman be placed between a meadow lit by the sun and the sun itself you will find that all the parts of the folds [of her dress] which are turned towards the meadow will be dyed by the reflected rays to the colour of the meadow ; and thus she becomes changed into the colours of the objects near, both those luminous and those non-luminous. (*MS.* 2038, *Bib. Nat.* 20 *r.*)

OF COLOURS

Of colours of equal whiteness that will seem most dazzling which is on the darkest background, and black will seem most intense when it is against a background of greater whiteness.

Red also will seem most vivid when against a yellow background, and so in like manner with all the colours when set against those which present the sharpest contrast. (*C. A.* 184 *v. c.*)

PAINTING

Since white is not a colour but is capable of becoming the recipient of every colour, when a white object is seen

in the open air all its shadows are blue; and this comes about in accordance with the fourth proposition, which says that:—'the surface of every opaque body partakes of the colour of surrounding objects.' As therefore this white object is deprived of the light of the sun by the interposition of some object which comes between the sun and it, all that portion of it which is exposed to the sun and the atmosphere, continues to partake of the colour of the sun and the atmosphere, and that part which is not exposed to the sun remains in shadow, and only partakes of the colour of the atmosphere. And if this white object should neither reflect the green of the fields which stretch out to the horizon nor yet face the brightness of the horizon itself, it would undoubtedly appear of such simple colour as the atmosphere showed itself to be. (*F* 75 *r.*)

OF PAINTING

The colour of the object illuminated partakes of the colour of that which illuminates it. (*G* 37 *r.*)

The colours of the middle of the rainbow mingle with each other.

The bow itself is neither in the rain nor in the eye that sees it, although it is produced by the rain, the sun, and the eye.

The rainbow is invariably seen by the eye which is situated between the rain and the body of the sun, and consequently when the sun is in the east and the rain in the west the rainbow is produced upon the western rain. (*E cover* 1 *v.*)

HOW THE PAINTER OUGHT TO PRACTISE HIMSELF IN THE PERSPECTIVE OF COLOURS

As a means of practising this perspective of the variation and loss or diminution of the proper essence of colours, take at distances a hundred braccia apart objects standing in the landscape, such as trees, houses, men, and places, and in front of the first tree fix a piece of glass so that it is quite steady, and then let your eye rest upon it and trace out a tree upon the glass above the outline of the tree; and afterwards remove the glass so far to one side that the actual tree seems almost to touch the one that you have drawn. Then colour your drawing in such a way that the two are alike in colour and form, and that if you close one eye both seem painted on the glass and the same distance away. Then proceed in the same way with a second and a third tree at distances of a hundred braccia from each other. And these will always serve as your standards and teachers when you are at work on pictures where they can be applied, and they will cause the work to be successful in its distance. But I find that it is a rule that the second is reduced to four-fifths the size of the first when it is twenty braccia distant from it.

(*MS.* 2038, *Bib. Nat.* 22 *v.*)

OF PAINTING

The outlines and forms of each part of bodies in shadow are poorly distinguished in their shadows and lights, but in such parts as are between the lights and shadows parts of these bodies are of the first degree of distinctness. (*G* 32 *r.*)

THE BOUNDARIES OF BODIES ARE THE LEAST OF ALL THINGS

The truth of this proposition is proved by the fact that the boundary of the substance is a surface, which is neither a part of the body enclosed by this surface nor a part of the atmosphere which surrounds this body, but is the medium interposed between the atmosphere and the body, as is proved in its place. But the lateral boundaries of these bodies are the boundary line of the surface, which line is of invisible thickness. Therefore, O painter, do not surround your bodies with lines, and especially when making objects less than their natural size, for these not only cannot show their lateral boundaries, but their parts will be invisible from distance. (*G* 37 *r.*)

OF LIGHTS

The lights which illumine opaque bodies are of four kinds, that is to say universal as that of the atmosphere within our horizon, and particular like that of the sun or of a window or door or other space; and the third is reflected light; and there is also a fourth which passes through substances of the degree of transparency of linen or paper or such like things, but not those transparent like glass or crystal or other diaphanous bodies with which the effect is the same as if there was nothing interposed between the body in shadow and the light that illumines it; and of these we shall treat separately in our discourse. (*G* 3 *v.*)

OF THE ATMOSPHERE INTERPOSED BETWEEN THE EYE AND THE VISIBLE OBJECT

The object will appear more or less distinct at the same distance in proportion as the atmosphere interposed between the eye and this object is of greater or less clearness. Since therefore you are aware that the greater or less quantity of atmosphere interposed between the eye and the object causes the outlines of these objects to seem more or less blurred to the eye, you should represent the stages of loss of definiteness of these bodies in the same proportion to each other as that of their distances from the eye of the beholder.

(*E* 79 *v.*)

HOW THE CONDITION OF THE ATMOSPHERE AFFECTS THE LIGHTS AND SHADOWS

That body will present the strongest contrast between its lights and shadows which is seen by the strongest light, such as the light of the sun or at night by the light of a fire; but this should rarely be employed in painting because the works will remain hard and devoid of grace.

A body which is in a moderate light will have but little difference between its lights and shadows; and this comes to pass at the fall of the evening, or when there are clouds: works painted then are soft in feeling and every kind of face acquires a charm. Thus in every way extremes are injurious. Excess of light makes things seem hard;[1] and too much darkness

[1] MS. has 'il tropo lume fa crudo.' So also Dr. Richter. The text of M. Ravaisson-Mollien in place of 'fa crudo' has 'facendo.'

does not admit of our seeing them. The mean is excellent.

OF SMALL LIGHTS

The lights cast from small windows also present a strong contrast of light and shadow, more especially if the chamber lit by them is large; and this is not good to use in painting. (*MS.* 2038, *Bib. Nat.* 33 *v.*)

AT WHAT HEIGHT THE LIGHT SHOULD BE IN ORDER TO DRAW FROM NATURE

When you are drawing from nature the light should be from the north, so that it may not vary; and if it is from the south keep the window covered with a curtain so that though the sun shine upon it all day long the light will undergo no change. The elevation of the light should be such that each body casts a shadow on the ground which is of the same length as its height.

(*MS.* 2038, *Bib. Nat.* 33 *r.*)

WHY BEAUTIFUL COLOURS SHOULD BE IN THE LIGHTS

Since we see that the quality of colours becomes known by means of light, it is to be inferred that where there is most light there the true quality of the colour so illuminated will be most visible, and where there is most shadow there the colour will be most affected by the colour of the shadow. Therefore, O painter, be mindful to show the true quality of the colours in the parts which are in light. (*MS.* 2038, *Bib. Nat.* 33 *r.*)

HOW ONE OUGHT TO ARRANGE THE LIGHT UPON FIGURES

The disposition of the light should be in harmony with the natural conditions under which you represent your figure; that is if you are representing it in sunlight, make the shadows dark with great spaces of light, and mark the shadows of all the surrounding bodies and their shadows upon the ground. If you represent it in dull weather, make only a slight difference between the lights and the shadows, and do not make any other shadow at the feet. If you represent it within doors, make a strong difference between the lights and shadows and show the shadow on the ground.

And if you represent a window covered by a curtain and the wall white there should be little difference between the lights and shadows. If it is lit by a fire you should make the lights ruddy and powerful and the shadows dark; and where the shadows strike the walls or the floor should be sharply defined, and the farther away they extend from the body the broader and larger should they become. And if it be lit in part by the fire and in part by the atmosphere, make the part lit by the atmosphere the stronger, and let that lit by the fire be almost as red as fire itself. And above all let the figures that you paint have sufficient light and from above, that is all living persons whom you paint, for the people whom you see in the streets are all lighted from above; and I would have you know that you have no acquaintance so intimate but that if the light fell on him from below you would find it difficult to recognise him.

(*MS.* 2038, *Bib. Nat.* 33 *r.*)

OF THE JUDGMENT THAT YOU OUGHT TO PASS UPON THE WORK OF A PAINTER

First you should consider the figures whether they have the relief which their position requires, and the light that illuminates them, so that the shadows may not be the same at the extremities of the composition as in the centre, because it is one thing for a figure to be surrounded by shadows, and another for it to have the shadows only on one side. Those figures are surrounded by shadows which are towards the centre of the composition, because they are shaded by the dark figures interposed between them and the light; and those are shaded on one side only which are interposed between the light and the main group, for where they do not face the light they face the group, and there they reproduce the darkness cast by this group, and where they do not face the group they face the brightness of the light, and there they reproduce its radiance.

Secondly, you should consider whether the distribution or arrangement of the figures is devised in agreement with the conditions you desire the action to represent.

Thirdly, whether the figures are actively engaged on their purpose. (*G* 19 *r.*)

OF THE LIGHTS ON THE LOWER EXTREMITIES OF BODIES PACKED TIGHTLY TOGETHER SUCH AS MEN IN BATTLE

Of men and horses labouring in battle the different parts should be darker in proportion as they are closer to the ground on which they are supported; and this is

proved from the sides of wells, which become darker in proportion to their depth, this being due to the fact that the lowest part of the well sees and is seen by a lesser amount of the luminous atmosphere than any other part of it. And the pavements when they are the same colour as the legs of the men and horses will always seem in higher light within equal angles than will these same legs. (*G* 15 *r.*)

OF SITUATION

Take careful note of the situation of your figures, for you will have the light and shade different if the object is in a dark place with a particular light, and if it is in a bright place with the direct light of the sun, and different also if it is in a dark place with the diffused light of evening or in dull weather, and if it is in the diffused light of the atmosphere lit by the sun.

(*G* 33 *v.*)

OF SHADOWS AND LIGHTS

You, who reproduce the works of nature, behold the dimensions, the degrees of intensity, and the forms of the lights and shadows of each muscle, and observe in the lengths of their figures towards which muscle they are directed by the axis of their central lines.

(*E* 3 *r.*)

IV. LANDSCAPE

OF CITIES OR OTHER BUILDINGS SEEN IN THE EVENING OR MORNING IN THE MIST

Buildings seen at a great distance in the evening or morning through mist or heavy atmosphere, have only

such portions in light as are illuminated by the sun which is then near the horizon, and the parts of these buildings which are not exposed to the sun remain almost the same dim neutral colour as the mist. (*E* 3 *v.*)

OF TREES IN THE SOUTH

When the sun is in the east, the trees in the south and north are almost as much in light as in shadow, but the total amount in light is greater in proportion as they are more to the west, and the total amount in shadow is greater in proportion as they are more to the east.

OF MEADOWS

When the sun is in the east, the grasses in the meadows and the other small plants are of a most brilliant green, because they are transparent to the sun. This does not happen with the meadows in the west, and in those in the south and north, the grasses are of a moderate brilliance in their green. (*G* 20 *v.*)

THE ASPECTS OF LANDSCAPES

When the sun is in the east, all the parts of trees which are illuminated by it are of a most brilliant green; and this is due to the fact that the leaves illuminated by the sun within half our hemisphere, namely the eastern half, are transparent; while within the western semicircle the verdure has a sombre hue and the air is damp and heavy, of the colour of dark ashes, so that it is not transparent like that in the east, which is refulgent, and the more so as it is more full of moisture.

The shadows of the trees in the east cover a large part of the tree, and they are darker in proportion as the trees are thicker with leaves. (*G* 21 *r.*)

OF TREES IN THE EAST

When the sun is in the east, the trees seen towards the east will have the light surrounding them all around their shadows, except towards the earth, unless the tree has been pruned in the previous year ; and the trees in the south and in the north will be half in shadow and half in light, and more or less in shadow or in light according as they are more or less to the east or to the west.

The fact of the eye being high or low causes a variation in the shadows and lights of trees, for when the eye is above, it sees the trees with very little shadow, and when below with a great deal of shadow.

The different shades of green of plants are as varied as are their species. (*G* 21 *v.*)

OF THE SHADOWS OF TREES

When the sun is in the east, the trees towards the west will appear to the eye with very little relief and of almost imperceptible gradation, on account of the atmosphere which lies very thick between the eye and these trees, according to the seventh [part] of this [treatise]; and they are deprived of shadow, for although a shadow exists in each part of the ramification, it so happens that the images of shadow and light which come to the eye are confused and blended together, and cannot

be discerned through the smallness of their size. And the highest lights are in the centre of the trees and the shadows are towards their extremities, and their separation is marked by the shadows in the spaces between these trees when the forests are dense with trees; and in those which are more scattered the contours are but little seen. (*G* 22 *r.*)

OF TREES IN THE EAST

When the sun is in the east, the trees in that quarter are dark towards the centre and their edges are in light.

OF THE SMOKE OF CITIES

The smoke is seen better and more distinctly in the eastern than in the western quarter when the sun is in the east. This is due to two causes; the first is that the sun shines through the particles of this smoke with its rays, and lightens these up and renders them visible; the second is that the roofs of the houses seen in the east at this hour are in shadow, because their slope prevents them from being lighted by the sun; the same happens with the dust, and both the one and the other are more charged with light in proportion as they are thicker, and they are thickest towards the middle. (*G* 22 *v.*)

OF SMOKE AND DUST

When the sun is in the east, the smoke of cities will not be visible in the west, because it is neither seen penetrated by the solar rays nor against a dark background, since the roofs of the houses turn the same side

to the eye that they show to the sun, and against this bright background the smoke will be scarcely visible. But dust when seen under the same conditions will appear darker than smoke, because it is thicker in substance than smoke which is made up of vapour.

(*G* 23 *r.*)

OF SHADOWS AND LIGHTS ON CITIES

When the sun is in the east and the eye is looking down upon a city from above, the eye will see the southern part of the city, with its roofs half in shadow and half in light, and so also with the northern part; but the eastern part will be all in shadow and the western part all in light. (*G* 19 *v.*)

OF PAINTING

Of the various colours other than blue, that which at a great distance will resemble blue most closely, will be that which is nearest to black, and so conversely the colour which least resembles black will be the one which at a great distance will most retain its natural colour.

Accordingly the green in landscapes will become more changed into blue than will the yellow or the white, and so conversely the yellow and the white will undergo less change than the green, and the red still less.

(*L* 75 *v.*)

OF LANDSCAPES

The dark colours of the shadows of mountains at a great distance take a more beautiful and purer blue than do those parts which are in light, and from this it follows

that when the rock of the mountains is reddish, the parts of it which are in light are fawn-coloured, and the more brightly it is illuminated the more closely will it retain its natural colour. (*I* 48 *r.*)

PAINTING

The landscapes which occur in representations of winter should not show the mountains blue as one sees them in summer, and this is proved by the fourth part of this [chapter], where it is stated that of the mountains seen at a great distance that will seem a deeper blue in colour which is in itself darker; for when the trees are stripped of their leaves they look grey in colour, and when they are with their leaves they are green, and in proportion as the green is darker than the grey, the green will appear a more intense blue than the grey; and by the fifth part of this [chapter], the shadows of trees which are clad with leaves are as much darker than the shadows of those trees which are stripped of leaves as the trees clad with leaves are denser than those without leaves; and thus we have established our proposition.

The definition of the blue colour of the atmosphere supplies the reason why landscapes are a deeper shade of blue in summer than in winter. (*E* 19 *r.*)

OF HOW TO PAINT WIND

In representing wind, in addition to showing the bending of the boughs and the inverting of their leaves at the approach of the wind, you should represent the clouds of fine dust mingled with the troubled air. (*E* 6 *v.*)

OF HOW TO DEPICT A WILD LANDSCAPE

Those trees and shrubs which are more split up into a quantity of thin branches ought to have less density of shadow. The tree and the shrubs which have larger leaves cast a greater shadow. (*MS.* 2038, *Bib. Nat.* 31 *v.*)

OF TREES AND THEIR LIGHT

The true method of practice in representing country scenes, or I should say landscapes with their trees, is to choose them when the sun in the sky is hidden, so that the fields receive a diffused light and not the direct light of the sun, for this makes the shadows sharply defined and very different from the lights. (*G* 11 *v.*)

OF TREES

What outlines do trees show at a distance against the atmosphere which serves as their background? The outlines of the structure of trees against the luminous atmosphere as they are more remote approach the spherical more closely in their shape, and as they are nearer so they display a greater divergence from the spherical form. So the first tree *a*[1] as being near to the eye displays the true form of its ramification, but this is somewhat less visible in *b*, and disappears altogether in *c*, where not only can none of the branches of the tree be seen, but the whole tree can only be recognised with great difficulty.

Every object in shadow,—be it of whatever shape you please,—will at a great distance appear to be spherical; and this occurs because if an object be rectangular, then at

[1] MS. contains a sketch of a row of trees seen in perspective.

GROVE OF SILVER BIRCHES

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a very short distance its angles become invisible, and a little farther off it loses more than it retains of the lesser sides, and so before losing the whole it loses the parts, since these are less than the whole. So with a man when so situated you lose sight of the legs, arms, and head, before the trunk, and then the extremities of the length become lost before those of the breadth, and when these have become equal there would be a square[1] if the angles remained, but as they are lost there is a sphere. (*G* 26 *v.*)

HOW ONE SHOULD REPRESENT LANDSCAPES

Landscapes ought to be represented so that the trees are half in light and half in shadow; but it is better to make them when the sun is covered in clouds, for then the trees are lighted up by the general light of the sky and the general shadow of the earth; and these are so much darker in their parts in proportion as these parts are nearer to the middle of the tree and to the earth.

(*G* 19 *v.*)

OF TREES WHICH ARE ILLUMINATED BY THE SUN OR BY THE ATMOSPHERE

The trees illuminated by the sun and by the atmosphere which have leaves of a dark colour will be illuminated on one side by the atmosphere alone, and in consequence of being thus illuminated will share its blueness; and on the opposite side they will be illuminated both by the atmosphere and the sun, and the part which the eye sees illuminated by the sun will be resplendent.

(*G* 28 *v.*)

[1] I have followed Dr. Richter in interpreting a tiny figure in the text as a square. M. Ravaisson-Mollien reads it as 'ci.'

OF THE SHADOWS OF VERDURE

The shadows of verdure always approximate to blue, and so it is with every shadow of every other thing, and they tend to this colour more entirely when they are further distant from the eye, and less in proportion as they are nearer.

The leaves which reflect the blue of the atmosphere always present themselves edgewise to the eye.

OF THE ILLUMINATED PARTS OF VERDURE AND OF MOUNTAINS

The part illuminated will show more of its natural colour at a great distance when it is illuminated by the most powerful light. (*G* 15 *r.*)

In the representation of trees in leaf be careful not to repeat the same colour too often for a tree which has another tree of the same colour as its background, but vary it by making the foliage lighter or darker or of a more vivid green. (*G* 27 *v.*)

The extremities of the branches of trees if not dragged down by the weight of their fruit turn towards the sky as much as possible.

The upper sides of their leaves are turned towards the sky in order to receive nourishment from the dew that falls by night.

The sun gives spirit and life to plants and the earth nourishes them with moisture. In this connection I once made the experiment of leaving only one small root on a gourd and keeping this nourished with water;

and the gourd brought to perfection all the fruits that it could produce, which were about sixty gourds of the long species; and I set myself diligently to consider the source of its life, and I perceived that it was the dew of the night which steeped it abundantly with its moisture through the joints of its great leaves, and thereby nourished the tree and its offspring, or rather the seeds which were to produce its offspring.

The rule as to the leaves produced on the last of the year's branches is that on twin branches they will grow in a contrary direction, that is, that the leaves in their earliest growth turn themselves round towards the branch in such a way that the sixth leaf above grows over the sixth leaf below; and the manner of their turning is that if one turns towards its fellow on the right, the other turns to the left.

The leaf serves as a breast to nourish the branch or fruit which grows in the succeeding year. (*G* 32 *v.*)

OF THE PLANTS OF THE FIELDS

Of the plants which take their shadows from the trees which grow among them, those which are in front of the shadow have their stalks lighted up against a background of shadow, and the plants which are in shadow have their stalks dark against a light background, that is against a background which is beyond the shadow.

OF THE TREES WHICH ARE BETWEEN THE EYE AND THE LIGHT

Of the trees which are between the eye and the light, the part in front will be bright, and this brightness will

be diversified by the ramification of the transparent leaves—as seen from the under side,—with the shining leaves seen from the right side, and in the background, below and behind, the verdure will be dark, because it is cast in shadow by the front part of the said tree; and this occurs in trees which are higher than the eye.

(*G* 9 *v.*)

OF DARK LEAVES IN FRONT OF TRANSPARENT ONES

When the leaves are interposed between the light and the eye, then that which is nearest to the eye will be the darkest, and that farthest away will be the lightest, if they are not seen against the atmosphere; and this happens with leaves which are beyond the centre of the tree, that is in the direction of the light. (*G* 10 *v.*)

OF THE LIGHTS ON DARK LEAVES

The lights on such leaves as are darkest in colour will most closely resemble the colour of the atmosphere reflected in them; and this is due to the fact that the brightness of the illuminated part mingling with the darkness forms of itself a blue colour; and this brightness proceeds from the blue of the atmosphere which is reflected in the smooth surface of these leaves, thereby adding to the blueness which this light usually produces when it falls upon dark objects.

OF THE LIGHTS ON LEAVES OF YELLOWISH GREEN

But leaves of yellowish green do not when they reflect the atmosphere create a reflection which verges on blue; for every object when seen in a mirror takes in part the

colour of this mirror; therefore the blue of the atmosphere reflected in the yellow of the leaf appears green, because blue and yellow mixed together form a most brilliant green, and therefore the lustre on light leaves which are yellowish in colour will be a greenish yellow. (*G* 28 *v.*)

The shadows of plants are never black, for where the atmosphere penetrates there cannot be utter darkness. (*G* 8 *r.*)

The leaf always turns its upper side towards the sky so that it may be better able to receive over its whole surface the dew which drops down with the slow movement of the atmosphere; and these leaves are arranged on the plants in such a way that one covers another as little as possible, but they lie alternately one above the other as is seen with the ivy which covers the walls. And this alternation serves two ends; that is in order to leave spaces so that the air and the sun may penetrate between them, —and the second purpose of it is that the drops which fall from the first leaf may fall on to the fourth, or on to the sixth in the case of other trees. (G 27 *v.*)

The shadows on transparent leaves seen from beneath are the same as those on the right side of the leaf, for the shadow is visible in transparence on the under side as well as the part in light; but the lustre can never be seen in transparence. (*G* 3 *v.*)

Although leaves with a smooth surface are for the most part of the same colour on the right side as on the reverse, it so happens that the side exposed to the atmo-

It is very useful to make some of the lower branches, and these should be dark, and should serve as a background for the illuminated belts of green which are at some little distance from the first.

Of the darker greens seen from below, that part is darkest which is nearest to the eye, that is to say which is farthest from the luminous atmosphere. (*G* 4 *r.*)

Never represent leaves as though transparent in the sun, because they are always indistinct; and this comes about because over the transparency of one leaf there will be imprinted the shadow of another leaf which is above it; and this shadow has definite outlines and a fixed density. And sometimes it is the half or third part of the leaf which is in the shadow, and consequently the structure of such a leaf is indistinct, and the imitation of it is to be avoided.

The upper branches of the spreading boughs of trees keep nearer to the parent bough than do those below.

That leaf is less transparent which takes the light at a more acute angle. (*G* 4 *v.*)

OF THE WAY TO PRESENT DISTANT OBJECTS IN PAINTING

It is evident that the part of the atmosphere which lies nearest the level ground is denser than the rest, and that the higher it rises the lighter and more transparent it becomes.

In the case of large and lofty objects which are some distance away from you, their lower parts will not be much seen, because the line by which you should see

them passes through the thickest and densest portion of the atmosphere. But the summits of these heights are seen along a line which, although when starting from your eye it is produced through the denser atmosphere, yet since it ends at the highest summit of the object seen, concludes its course in an atmosphere far more rarefied than that of its base. And consequently the farther away from you this line extends from point to point the greater is the change in the finer quality of the atmosphere.

Do you, therefore, O Painter, when you represent mountains, see that from hill to hill the bases are always paler than the summits, and the farther away you make them one from another let the bases be paler in proportion, and the loftier they are, the more they should reveal their true shape and colour.

(*MS.* 2038, *Bib. Nat.* 18 *r.*)

HOW THE ATMOSPHERE SHOULD BE REPRESENTED AS PALER IN PROPORTION AS YOU SHOW IT EXTENDING LOWER

Since the atmosphere is dense near the ground, and the higher it is the finer it becomes, therefore when the sun is in the east and you look towards the west, taking in a part to the north and to the south, you will see that this dense air receives more light from the sun than the finer air, because the rays encounter more resistance. And if your view of the horizon is bounded by a low plain, that farthest region of the sky will be seen through that thicker whiter atmosphere, and this will destroy the truth of the colour as seen through such a

medium; and the sky will seem whiter there than it does overhead, where the line of vision traverses a lesser space of atmosphere charged with thick vapours. But if you look towards the east the atmosphere will appear darker in proportion as it is lower, for in this lower atmosphere the luminous rays pass less freely.

(*MS.* 2038, *Bib. Nat.* 18 *v.*)

BOOK IV

FANTASY

FABLES

THE unhappy willow on finding herself unable to enjoy the pleasure of seeing her slender boughs attain to such a height as she desired, or even point towards the sky, because she was continually being maimed and lopped and spoiled for the sake of the vine or any other tree which happened to be near, summoned up all her faculties and by this means opened wide the portals of her imagination, remaining in continual meditation, and seeking in the world of plants for one wherewith to ally herself which could not need the help of her branches. So continuing for a time with her imagination at work, the thought of the gourd suddenly presented itself to her mind, and all her branches quivered in her intense joy, for it seemed to her that she had found the right companion for the purpose she desired, because the gourd is by nature more fitted to bind others than to be bound herself. After coming to this conclusion she lifted up her branches towards the sky and waited, on the look-out for some friendly bird to serve as the intermediary of her desire. Among the rest she descried the magpie near to her and said to him, 'O gentle bird, by the refuge you have lately found among my branches at

dawn, when the hungry, cruel, and rapacious falcon has wished to devour you,—by that rest you have often found in me when your wings craved rest,—by those delights you have enjoyed among my branches in amorous dalliance with your companions,—I entreat you to go and seek out the gourd and obtain from her some of her seeds, telling her that I will care for whatever is born from them as though they were my own offspring, and in like manner use all such words as may incline her to the like purpose, though to you who are a master of language there is no need for me to give instruction. If you will do this I am content to let your nest be in the fork of my boughs together with all your family without payment of any rent.' So the magpie after stipulating with the willow for certain further conditions, the most important being that she should never admit upon her boughs any snake or polecat, cocked his tail and lowered his head, and casting himself loose from the bough let himself float on his wings ; and beating about with these in the fleeting air, seeking hither and thither, and guiding himself by using his tail as a rudder, he came to a gourd, and after courteously saluting her obtained by a few polite words the seeds for which he sought. On taking these back to the willow he was welcomed with joyful looks ; and then scraping away with his foot some of the earth near the willow he planted the grains with his beak round about her in a circle.

These soon began to grow, and as the branches increased and opened out they began to cover all the branches of the willow, and their great leaves shut away from it the beauty of the sun and the sky. And all this evil not

sufficing, the gourds next began to drag down to the ground in their rude grip the tops of the slender boughs, twisting and distorting them in strange shapes. Then the willow after shaking and tossing herself to no purpose to make the gourds loose their hold, and vainly for days cherishing such idle hopes, since the grasp of the gourds was so sure and firm as to forbid such thoughts, seeing the wind pass by, forthwith commended herself to it. And the wind blew hard; and it rent open the willow's old and hollow trunk, tearing it in two parts right down to its roots; and as they fell asunder she vainly bewailed her fate, confessing herself born to no good end. (*C. A.* 67 *r. b.*)

The thrushes rejoiced greatly on seeing a man catch the owl and take away her liberty by binding her feet with strong bonds. But then by means of birdlime the owl was the cause of the thrushes losing not only their liberty but even their life. This is said of those states which rejoice at seeing their rulers lose their liberty, in consequence of which they afterwards lose hope of succour and remain bound in the power of their enemy, losing their liberty and often life.

(*C. A.* 117 *r. b.*)

A certain patch of snow finding itself clinging to the top of a rock which was perched on the extreme summit of a very high mountain, being left to its own imagination began to reflect and to say within itself:—'Shall I not be thought haughty and proud for having placed myself in so exalted a spot,—being indeed a mere morsel of snow? And for allowing that such a vast quantity of

snow as I see around me should take a lower place than mine? Truly my small dimensions do not deserve this eminence; and in proof of my insignificance I may readily acquaint myself with the fate which but yesterday befell my companions who in a few hours were destroyed by the sun; and this came about from their having placed themselves in a loftier station than was required of them. I will flee from the wrath of the sun, and abase myself, and find a place that befits my modest size.'

Then throwing itself down, it began to descend, rolling down from the lofty crags on to the other snow; and the more it sought a lowly place, the more it increased in bulk, until at last ending its course upon a hill it found itself almost the equal in size of the hill on which it rested, and it was the last of the snow which was melted that summer by the sun.

This is said for those who by humbling themselves are exalted. (*C. A. 67 v. b.*)

A nut which found itself carried by a crow to the top of a lofty campanile, having there fallen into a crevice and so escaped its deadly beak, besought the wall by that grace which God had bestowed upon it in causing it to be so exalted and great, and so rich in having bells of such beauty and of such mellow tone, that it would deign to give it succour; that insomuch as it had not been able to drop beneath its old father's green branches and lie in the fallow earth covered by his fallen leaves the wall would not abandon it, for when it found itself in the fierce crow's cruel beak it had vowed that if it escaped thence it would end its days in a small hole. At

these words the wall, moved with compassion, was content to give it shelter in the spot where it had fallen. And within a short space of time the nut began to burst open and to put its roots in among the crevices of the stones and push them further apart and throw up shoots out of its hollow, and these soon rose above the top of the building ; and as the twisted roots grew thicker they commenced to tear asunder the walls and force the ancient stones out of their old positions. Then the wall too late and in vain deplored the cause of its destruction, and in a short time it was torn asunder and a great part fell in ruin. (*C. A.* 67 *r. a.*)

The privet on feeling its tender branches, laden with new fruit, pricked by the sharp claws and beak of the troublesome blackbird, complained to her with pitiful reproaches beseeching her that even if she plucked off her delicious fruit she would at any rate not deprive her of her leaves which protected her from the scorching rays of the sun, nor with her sharp claws rend away and strip bare her tender bark. But to this the blackbird replied with insolent rebuke :—'Silence! rude bramble! Know you not that nature has made you to produce these fruits for my sustenance? Cannot you see that you came into the world in order to supply me with this very food? Know you not, vile thing that you are, that next winter you will serve as sustenance and food for the fire?' To which words the tree listened patiently and not without tears.

But a short time afterwards the blackbird was caught in a net, and some boughs were cut to make a cage in

order to imprison her, and among the rest were some cut from the tender privet to serve for the rods of the cage; and these on perceiving that they would be the cause of the blackbird being deprived of liberty rejoiced and uttered these words:—'We are here, O blackbird, not yet consumed by the fire as you said; we shall see you in prison before you see us burnt.'

(*C. A.* 67 *r. a.*)

Some flames had already lived for a month in a glass furnace when they saw a candle approaching in a beautiful and glittering candlestick. They strove with great longing to reach it; and one of their number left its natural course and wound itself into an unburnt brand upon which it fed, and then passed out at the other end by a small cleft to the candle which was near, and flung itself upon it, and devouring it with the utmost voracity and greed consumed it almost entirely; then desirous of prolonging its own life, it strove in vain to return to the furnace which it had left, but was forced to droop and die together with the candle. So at last in lamentation and regret it was changed to foul smoke, leaving all its sisters in glowing and abiding life and beauty.

(*C. A.* 67 *r. b.*)

The fig-tree standing near to the elm, and perceiving that her boughs bore no fruit themselves, yet had the hardihood to keep away the sun from her own, unripe figs, rebuked her, saying: 'O Elm, are you not ashamed to stand in front of me? Only wait until my children are fully grown and you will see where you will find yourself.' But when her offspring were ripe a regiment

of soldiers came to the place, and they tore off the branches of the fig-tree in order to take her figs and left her all stripped and broken.

And as she thus stood maimed in all her limbs the elm questioned her saying, 'O Fig-tree, how much better was it to be without children than to be brought by them to so wretched a pass?' (*C. A.* 76 *r. a.*)

Once upon a time the razor emerging from the handle which served it as a sheath, and placing itself in the sun, saw the sun reflected on its surface, at which thing it took great pride, and turning it over in its thoughts it began to say to itself, 'Am I to go back any more to that shop from which I have just now come away? No surely! It cannot be the pleasure of the gods that such radiant beauty should stoop to such vile uses! What madness would that be which should induce me to scrape the lathered chins of rustic peasants and to do such menial service! Is this body made for actions such as these? Certainly not! I will go and hide myself in some retired spot, and there pass my life in tranquil ease.'

And so having hid itself away for some months, returning one day to the light and coming out of its sheath it perceived that it had acquired the appearance of a rusty saw, and that its surface no longer reflected the sun's radiance. In vain with useless repentance it bemoaned its irreparable hurt, saying to itself, 'Ah how much better would it have been to have let the barber use that lost edge of mine that had so rare a keenness! Where now is the glittering surface? In truth the foul insidious rust has consumed it away!'

The same thing happens with minds which in lieu of exercise give themselves up to sloth; for these like the razor lose their keen edge, and the rust of ignorance destroys their form. (*C. A.* 175 *v. a.*)

A stone of considerable size, only recently left uncovered by the waters, stood in a certain spot perched up at the edge of a delightful copse, above a stony road, surrounded by plants bright with various flowers of different colours, and looked upon the great mass of stones which lay heaped together in the road beneath. And she became filled with longing to let herself down there, saying within herself: 'What am I doing here with these plants? I would fain dwell in the company of my sisters yonder'; and so letting herself fall she ended her rapid course among her desired companions. But when she had been there for a short time she found herself in continual distress from the wheels of the carts, the iron hoofs of the horses and the feet of the passers-by. One rolled her over, another trampled upon her; and at times she raised herself up a little as she lay covered with mud or the dung of some animal, and vainly looked up at the place from whence she had departed as a place of solitude and quiet peace.

So it happens to those who leaving a life of solitude and contemplation choose to come and dwell in cities among people full of infinite wickedness. (*C. A.* 175 *v. a.*)

As the painted butterfly was idly wandering and flitting about through the darkened air a light came within sight, and thither immediately it directed its course, and

flew round about it in varying circles marvelling greatly at such radiant beauty. And not contented merely to behold, it began to treat it as was its custom with the fragrant flowers, and directing its flight it approached with bold resolve close to the light, which thereupon consumed the tips of its wings and legs and the other extremities; and then dropping down at the foot of it, it began to consider with astonishment how this accident had been brought about, for it could not so much as entertain a thought that any evil or hurt could possibly come to it from a thing so beautiful; and then having in part regained the strength which it had lost, it took another flight and passed right through the body of the flame, and in an instant fell down burned into the oil which fed the flame, preserving only so much life as sufficed it to reflect upon the cause of its destruction, saying to it, 'O accursed light! I thought that in you I had found my happiness! Vainly do I lament my mad desire, and by my ruin I have come to know your rapacious and destructive nature.'

To which the light replied, 'Thus do I treat whoever does not know how to use me aright.'

This is said for those who when they see before them these carnal and worldly delights, hasten towards them like the butterfly, without ever taking thought as to their nature, which they know after long usage to their shame and loss. (*C. A.* 257 *r. b.*)

The flint on being struck by the steel marvelled greatly and said to it in a stern voice, 'What arrogance prompts you to annoy me? Trouble me not, for you

have chosen me by mistake; I have never done harm to any one.' To which the steel made answer, 'If you will be patient you will see what a marvellous result will issue forth from you.' At these words the flint was pacified and patiently endured its martyrdom, and it saw itself give birth to the marvellous element of fire which by its potency became a factor in innumerable things.

This is said for those who are dismayed at the outset of their studies, and then set out to gain the mastery over themselves and in patience to apply themselves continuously to these studies, from which one sees result things marvellous to relate. (*C. A.* 257 *r. b.*)

The water on finding itself in the proud sea, its element, was seized with a desire to rise above the air; and aided by the element of fire, having mounted up in thin vapour, it seemed almost as thin as the air itself; and after it had risen to a great height it came to where the air was more rarefied and colder, and there it was abandoned by the fire; and the small particles being pressed together were united and became heavy; and dropping from thence its pride was put to rout, and it fell from the sky and was then drunk up by the parched earth, where for a long time it lay imprisoned and did penance for its sin. (*S. K. M. ii.* 2 *r.*)

The lily planted itself down upon the bank of the Ticino, and the stream carried away the bank and with it the lily. (*H* 44 *r.*)

The oyster being thrown out with other fish near to the sea from the house of a fisherman, prayed to a rat to

take him to the sea: the rat who was intending to devour him, bade him open, but then as he bit him the oyster squeezed his head and held it; and the cat came and killed him. (*H* 51 [3] *v.*)

The spider thinking to find repose within the key-hole, found death. (*C. A.* 299 *v. b.*)

The knife,—an artificial weapon—deprives man of his nails—his natural weapon.

The mirror bore itself proudly holding the queen mirrored within it, and after she has departed the mirror remains. (*S. K. M. iii.* 44 *v.*)

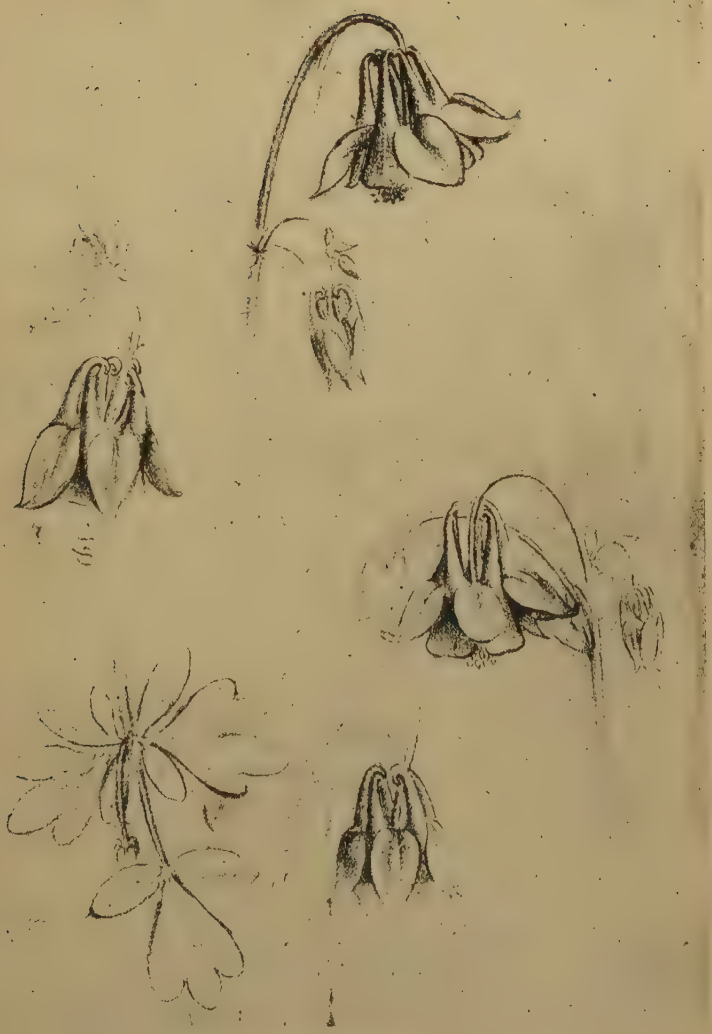
The paper on seeing itself all spotted by the obscure blackness of the ink grieves at it, and the ink shows it that by reason of the words composed upon it it becomes the cause of its preservation. (*S. K. M. iii.* 27 *r.*)

Loyalty. The cranes in order that their king may not perish by their keeping bad guard stand round him at night holding stones in their feet. Love, fear, and reverence—write these upon the three stones of the cranes. (*H* 118 [25 *v.*] *r.*)

FOR WELL-DOING

By the branch of the nut-tree which is struck and beaten just when it has brought its fruit to perfection, is represented those who as the sequel of their illustrious works are struck by envy in divers ways. (*G* 88 *v.*)

By the thorn upon which is grafted the good fruits is meant that which is not of itself predisposed to virtue,



COLUMBINE
(*Aquilegia Vulgaris*)

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yet by the help of an instructor itself produces the most useful virtues.

One pushes down another: by these cubes[1] are represented the life and conditions of mankind. (*G* 89 *r.*)

[FOR AN ALLEGORICAL REPRESENTATION]

Il Moro, as the figure of Fortune with hair and robes and with hands held in front, and Messer Gualtieri with act of obeisance plucks him by the robes from below as he presents himself before him.

Also Poverty as a hideous figure running behind a youth, whom Il Moro covers with the skirt of his robe while he threatens the monster with his gilded sceptre. (*I* 138 [90] *v.*)

[FOR AN ALLEGORICAL REPRESENTATION]

Il Moro with the spectacles and Envy represented with lying Slander, and Justice black for Il Moro.

Labour with the vine in her hand. (*H* 88 [40] *v.*)

The great bird will take its first flight upon the back of the great swan, filling the whole world with amazement and filling all records with its fame; and it will bring eternal glory to the nest where it was born. (*Sul Volo degli Uccelli, cover*, 2 *r.*)

To write thus clearly of the kite would seem to be my destiny, because in the earliest recollections of my infancy it seemed to me when I was in the cradle that a kite came and opened my mouth with its tail and struck me within upon the lips with its tail many times. (*C. A.* 66, *v. b.*)

[1] MS. has a diagram with dice.

Dear Benedetto,—To give you the news of the things here from the east, you must know that in the month of June there appeared a giant who came from the Libyan desert. This giant was born on Mount Atlas, and was black, and he fought against Artaxerxes with the Egyptians and Arabs, the Medes and Persians; he lived in the sea upon the whales, the great leviathans and the ships. When the savage giant fell by reason of the ground being covered over with blood and mire, it seemed as though a mountain had fallen; whereat the country [shook] as though there were an earthquake, with terror to Pluto in hell, and Mars fearing for his life fled for refuge under the side of Jove.[1] And from the violence of the shock he lay prostrate on the level ground as though stunned; until suddenly the people believing that he had been killed by some thunderbolt, began to turn about his great beard; and like a flock of ants that range about hither and thither furiously among the brambles beaten down by the axe of the sturdy peasant, so these are hurrying about over his huge limbs and piercing them with frequent wounds. At this the giant being roused, and perceiving himself to be almost covered by the crowd, suddenly on feeling himself smarting from their stabs, uttered a roar which seemed as though it were a terrific peal of thunder, and set his hands on the ground and lifted up his awe-inspiring countenance; and then placing one of his hands

[1] MS. 'Marte temedo dela vita sera fugito sotto lato dj giove.' These words in Leonardo's writing occur at the side and are not found in the transcript of the Italian edition. I have ventured to insert them where they seemed to best fit the sense, and also to change the order of some of the sentences which are written in the margin.

upon his head, he perceived it to be covered with men sticking to the hairs after the fashion of tiny creatures which are sometimes harboured there, and who, as they clung to the hairs and strove to hide among them, were like sailors in a storm who mount the rigging in order to lower the sail and lessen the force of the wind; and at this point he shook his head and sent the men flying through the air after the manner of hail when it is driven by the fury of the winds, and many of these men were found to be killed by those who fell on them like a tempest. Then he stood erect, trampling upon them with his feet.

(*C. A.* 311 *r. a.*)

The black visage at first sight is most horrible and terrifying to look upon, especially the swollen and blood-shot eyes set beneath the awful lowering eyebrows which cause the sky to be overcast and the earth to tremble. And believe me there is no man so brave but that, when the fiery eyes were turned upon him, he would willingly have put on wings in order to escape, for the face of infernal Lucifer would seem angelic by contrast with this.

The nose was turned up in a snout with wide nostrils and sticking out of these were quantities of large bristles, beneath which was the arched mouth, with the thick lips, at whose extremities were hairs like those of cats, and the teeth were yellow. He towered above the heads of men on horseback from the top of his feet upwards.

And as his cramped position had been irksome, and in order to rid himself of the importunity of the throng, his rage turned to frenzy, and he began to let his feet give vent to the frenzy which possessed his mighty limbs,

and entering in among the crowd he began by his kicks to toss men up in the air, so that they fell down again upon the rest as though there had been a thick storm of hail, and many were those who in dying dealt out death. And this barbarity continued until such time as the dust stirred up by his great feet, rising up in the air, compelled his infernal fury to abate, while we continued our flight.

Alas, how many attacks were made upon this raging fiend to whom every onslaught was as nothing! O wretched folk, for you there avail not the impregnable fortresses, nor the lofty walls of your cities, nor the being together in great numbers, nor your houses or palaces! There remained not any place unless it were the tiny holes and subterranean caverns where after the manner of crabs and crickets and creatures like these you might find safety and a means of escape. Oh, how many wretched mothers and fathers were deprived of their children! How many unhappy women were deprived of their companions! In truth, my dear Benedetto, I do not believe that ever since the world was created there has been witnessed such lamentation and wailing of people accompanied by so great terror. In truth, the human species in such a plight has need to envy every other race of creatures; for though the eagle has strength sufficient to subdue the other birds, they yet remain unconquered through the rapidity of their flight, and so the swallows through their speed escape becoming the prey of the falcon, and the dolphins also by their swift flight escape becoming the prey of the whales and of the mighty leviathans; but for us wretched mortals there avails not any flight, since this monster when

advancing slowly far exceeds the speed of the swiftest courser.

I know not what to say or do for everywhere I seem to find myself swimming with bent head within the mighty throat and remaining indistinguishable in death, buried within the huge belly. (*C. A.* 96 *v. b.*)

PROPHECIES

THE DIVISIONS OF THE PROPHECIES

First of things which relate to the reasoning animals, second those which have not the power of reason, third of plants, fourth of ceremonies, fifth of customs, sixth of propositions, decrees or disputes, seventh of propositions contrary to nature (as to speak of a substance which the more there is taken from it is the more increased), and reserve the weighty propositions until the end, and begin with those of less import, and show first the evils and then the punishments, eighth of philosophical things.

I

OF FOOD WHICH HAS BEEN ALIVE

A large part of the bodies which have had life will pass into the bodies of other animals, that is the houses no longer inhabited will pass piecemeal through those which are inhabited, ministering to their needs and bearing away with them what is waste; that is to say that the life of man is made by the things which he eats, and that these carry with them that part of man which is dead.

OF MEN WHO SLEEP UPON PLANKS MADE FROM TREES

Men will sleep and eat and make their dwelling among trees grown in the forests and the fields.

OF DREAMING

It shall seem to men that they see new destructions in the sky, and the flames descending therefrom shall seem to have taken flight and to flee away in terror; they shall hear creatures of every kind speaking human language; they shall run in a moment in person to divers parts of the world without movement; amidst the darkness they shall see the most radiant splendours. O marvel of mankind! What frenzy has thus impelled you! You shall hold converse with animals of every species, and they with you in human language. You shall behold yourselves falling from great heights without suffering any injury; the torrents will bear you with them as they mingle in their rapid course.

OF CHILDREN WHO ARE WRAPPED IN SWADDLING BANDS

O cities of the sea, I behold in you your citizens, women as well as men, tightly bound with stout bonds around their arms and legs by folk who will have no understanding of our speech; and you will only be able to give vent to your griefs and sense of loss of liberty by making tearful complaints and sighs and lamentation one to another, for those who bind you will not have understanding of your speech nor will you understand them. (*C. A.* 145 *r. a.*)

OF REAPERS

There will be many who will be moving one against another, holding in their hands the sharp cutting iron. These will not do each other any hurt other than that caused by fatigue, for as one leans forward the other draws back an equal space ; but woe to him who intervenes between them, for in the end he will be left cut in pieces.

OF THOSE WHO ARE BEATEN AND SCOURGED

Men will hide themselves within the bark of hollow trees, and there crying aloud they will make martyrs of themselves by beating their own limbs.

OF DREAMING

Men shall walk without moving, they shall speak with those who are absent, they shall hear those who do not speak.

OF SOLDIERS ON HORSEBACK

Many shall be seen carried by large animals with great speed to the loss of their lives and to instant death.

In the air and on the earth shall be seen animals of different colours bearing men furiously to the destruction of their lives. (*C. A.* 370 *r. a.*)

You shall behold the bones of the dead by their rapid movement directing the fortunes of their mover :—The dice. (*I* 64 [16] *v.*)

Men will deal rude blows to that which is the cause of their life :—They will thrash the grain.

The skins of animals will make men rouse from their silence with loud cries and oaths :—Balls for playing games.

The wind which passes through the skins of animals will make men leap up :—That is the bag-pipes which cause men to dance. (*I* [65] 17 *r.*)

OF CHILDREN WHO TAKE THE BREAST

Many Franciscans, Dominicans, and Benedictines will eat that which has recently been eaten by others, and they will remain many months before being able to speak. (*I* 67 [19] *r.*)

OF SHOEMAKERS

Men will take a pleasure in seeing their own works worn out and destroyed. (*S. K. M. ii.* 61 *v.*)

II

OF ANTS

Many communities will there be who will hide themselves and their young and their victuals within gloomy caverns, and there in dark places will sustain themselves and their families for many months without any light either artificial or natural.

OF BEES

And many others will be robbed of their store of provisions and their food, and by an insensate folk will be cruelly immersed and drowned. O justice of God ! why dost thou not awake to behold thy creatures thus abused ?

OF SHEEP, COWS, GOATS AND THE LIKE

From countless numbers will be stolen their little children, and the throats of these shall be cut, and they shall be quartered most barbarously.

OF CATS THAT EAT RATS

In you, O cities of Africa! your own sons shall be seen torn to pieces within their own houses by most cruel and savage animals of your country.

OF ASSES WHICH ARE BEATEN

O neglectful nature, wherefore art thou thus partial, becoming to some of thy children a tender and benignant mother, to others a most cruel and ruthless stepmother? I see thy children given into slavery to others without ever receiving any benefit, and in lieu of any reward for the services they have done for them they are repaid by the severest punishments, and they constantly spend their lives in the service of their oppressor. (*C. A.* 145 *r. a.*)

OF SNAKES CARRIED BY SWANS

Serpents of huge size will be seen at an immense height in the air fighting with birds. (*C. A.* 129 *v. a.*)

OF THE BELLS OF MULES WHICH ARE CLOSE TO THEIR EARS

There shall be heard in many parts of Europe instruments of various sizes making divers melodies, causing great weariness to those who hear them most closely.

OF ASSES

The many labours shall be repaid by hunger, thirst, wretchedness, blows, and goadings.

OF THE HAFTS OF KNIVES MADE OF RAMS' HORNS

In the horns of animals shall be seen sharp irons which shall take away the lives of many of their species.

(*C. A.* 370 *r. a.*)

OF BOWS MADE FROM THE HORNS OF OXEN

Many there will be who by means of the horns of cattle will die a painful death. (*C. A.* 370 *v. a.*)

You will see the lion tribe tearing open the earth with hooked claws, and burying themselves in the holes that they have made together with the other animals which are in subjection to them.

There shall come forth from the ground creatures clad in darkness who shall attack the human race with tremendous onslaughts, and it shall have the blood poisoned by their fierce bites even while it is devoured by them.

There shall also hurtle through the air a tribe of dreadful winged creatures who shall attack both men and beasts and feed upon them with loud cries.—They shall fill their bellies full of crimson blood. (*I* 63 [15] *r.*)

Oxen shall by their horns protect the fire from death: —The lantern. (*I* 64 [16] *v.*)

OF COCKLES AND SEA-SNAILS CAST UP BY THE SEA WHICH ROT WITHIN THEIR SHELLS

How many shall there be who after they are dead will lie rotting in their own houses, filling all the air around with their foul stench. (*I* 67 [19] *r.*)

OF KIDS

The time of Herod shall return; for the innocent children shall be torn away from their nurses and shall die of great wounds at the hands of cruel men. (*S. K. M. ii.* 9 *v.*)

The oxen will become in great part the cause of the destruction of cities and so likewise will horses and buffaloes:—They draw the guns. (*B. M.* 263, *Ar.* 42 *b.*)

III

OF NUTS, OLIVES, ACORNS, CHESTNUTS, AND THE LIKE

Many children shall be torn with pitiless beatings out of the very arms of their mothers and flung upon the ground and then maimed. (*C. A.* 145 *r. a.*)

OF WOOD THAT IS BURNT

The trees and shrubs of the vast forests shall be changed to ashes.

OF FLAX WHEREBY PAPER IS MADE OUT OF RAGS

That shall be revered and honoured and its precepts shall be listened to with reverence and love, which was at first despised and mangled and tortured with many different blows.

OF WOODEN COFFERS WHICH ENCLOSE MANY TREASURES

Within walnuts and other trees and plants there shall be found very great treasures which lie hidden there.

(*C. A.* 370 *r. a.*)

The forests will bring forth young who will become the cause of their death.—The handle of the hatchet.

(*I* 64 [16] *v*).

OF NUT TREES WHICH ARE BEATEN

Those which have done best will be most beaten, and their children will be carried off and stripped or despoiled, and their bones broken and crushed.

(*I* 65 [17] *v.*)

OF TREES WHICH GIVE SAP TO GRAFTED SHOOTS

Fathers and mothers shall be seen to bestow much more attention upon their step-children than upon their own children. (*B. M.* 263, *Ar.* 212 *b.*)

OF THE MOWING DOWN OF GRASS

Innumerable lives will be extinguished, and innumerable vacant spaces created upon the earth.

(*S. K. M. ii.* 34 *r.*)

IV

OF CHRISTIANS

There are many who hold the faith of the Son and only build temples in the name of the Mother.

(*C. A.* 145 *r. a.*)

RANUNCULUS REPENS (*Creeping Crowfoot*)

ORNITHOGALUM UMBELLIFERUM (*Star of Bethlehem*)

ANEMONE NEMOROSA (*Wood Anemone*)

EUPHORBIA ESULA (*Leafy-Branched Spurge*)

Face p. 274

OF FUNERAL RITES AND PROCESSIONS AND LIGHTS AND BELLS AND FOLLOWERS

The greatest honours and ceremonies shall be paid to men without their knowledge. (*C. A.* 145 *v. a.*)

OF THE WORSHIPPING OF PICTURES OF SAINTS

Men shall speak with men who shall not hear them; their eyes shall be open and they shall not see; they will speak to them and there shall be no reply; they will ask pardon from one who has ears and does not hear; they will offer light to one who is blind, and to the deaf they will appeal with loud clamour.[1]

OF THE LAMENTATIONS MADE ON GOOD FRIDAY

In all the parts of Europe there shall be lamentations by great nations for the death of one man.[2]

(*C. A.* 370 *r. a.*)

OF REMOVING ON ALL SAINTS' DAY

Many shall leave their own dwellings and shall carry with them all their goods and go to dwell in other lands.

OF ALL SOULS' DAY

How many will there be who will mourn for their dead ancestors, carrying lights for them!

OF FRIARS WHO BY SPENDING ONLY WORDS RECEIVE GREAT RICHES AND BESTOW PARADISE

Invisible money will cause many who spend it to triumph. (*C. A.* 370 *v. a.*)

[1] MS. 'faran lume a [chi] è orbo [. . .] sordi con gran [. . .] ore.'

[2] 'Who died in the East' follows in MS. but is crossed out.

OF THE RELIGION OF THE FRIARS WHO LIVE BY MEANS OF THE SAINTS WHO HAVE BEEN DEAD FOR A LONG TIME

Those who are dead will after a thousand years be those who will make provision for many of the living.

(*I* 66 [18] *v.*)

OF PRIESTS WHO SAY MASS

Many shall there be who in order to practise their calling shall put on the richest vestments, and these shall seem to be made after the manner of aprons.

OF FRIARS WHO HOLD CONFESSION

The unhappy women of their own accord shall go to reveal to men all their wantonness and their shameful and most secret acts.

OF THE CHURCHES AND HABITATIONS OF FRIARS

There will be many who will abandon work and labour and poverty of life and possessions, and will go to dwell among riches and in splendid buildings, pretending that this is a means of becoming acceptable to God.

OF THE SELLI[illegible] OF PARADISE

A countless multitude will sell publicly and without hindrance things of the very greatest value without licence from the Lord of these things, which were never theirs nor in their power; and human justice will take no account of this.

OF THE DEAD WHO ARE TAKEN TO BE BURIED

The simple folk will carry a great number of lights to light up the journeys of all those who have wholly lost the power of sight! O human folly! O madness of mankind! These two phrases stand for the commencement of the matter. (*C. A.* 370 *v. a.*)

OF SCULPTURE

Alas! whom do I see? The Saviour crucified again. (*I* 65 [17] *v.*)

OF CRUCIFIXES WHICH ARE SOLD

I see Christ again sold and crucified and His saints suffering martyrdom. (*I* 66 [18] *v.*)

OF PRIESTS WHO BEAR THE HOST IN THEIR BODIES

Then almost all the tabernacles where dwells the *Corpus Domini* will be plainly visible walking about of themselves on the different roads of the world. (*I* 65 [17] *v.*)

OF THE THURIBLE WITH INCENSE

Some shall go about in white vestments with arrogant gestures threatening others with metal and fire, which yet have never done them any harm. (*B. M.* 263, *Ar.* 212 *b.*)

And many have made a trade in deceits and feigned miracles, cozening the foolish herd, and if no one showed himself cognisant of their deceits they would impose them upon all. (*F* 5 *v.*)

Frati Santi spells Pharisees. (*Tr. Tav.* 63 *a.*)

That shall be drowned which supplies the light for divine service :—The bees which make the wax for the candles. (*B. M.* 263, *Ar.* 42 *b.*)

V

OF SILK SPINNING

There shall be heard mournful cries, and loud shrieks, hoarse, angry voices of those who are tortured and despoiled and at last left naked and motionless ; and this shall be by reason of the motive power which turns the whole.

OF FEATHERS IN BEDS

Flying creatures will support men with their feathers.

OF THE SOLES OF SHOES WHICH ARE OF LEATHER

Over a great part of the country men shall be seen walking about on the skins of large animals.

OF A STICK WHICH IS A DEAD THING

The movement of the dead shall cause many who are living to flee away with grief and lamentation and cries.

OF BEATING THE BED TO REMAKE IT

To such a pitch of ingratitude shall men come that that which shall give them lodging without any price shall be loaded with blows, in such a way that great parts of the inside of it shall be detached from their place and shall be turned over and over within it.

OF SHIPS THAT FOUNDER

There shall be seen huge bodies devoid of life, carrying great numbers of men with fierce speed to the destruction of their lives. (*C. A.* 370 *r. a.*)

OF SAILING IN SHIPS

The trees of the vast forests of Taurus and of Sinai, of the Apennines and of Atlas [1] shall be seen speeding by means of the air from East to West, and from North to South, and transporting by means of the air a great quantity of men. O, how many vows! How many deaths! What partings 'twixt friends and relatives shall there be! How many who shall never more behold their own lands or their native country, and shall die unsepulchred and their bones be scattered in divers parts of the world. (*C. A.* 370 *v. a.*)

Feathers shall raise men even as they do birds towards heaven:—That is by letters written with their quills. (*I* 64 [16] *v.*)

Many times the thing that is severed becomes the cause of great union:—That is the comb made up of split canes which unites the threads in the silk. (*I* 65 [17] *r.*)

And those who feed the air will turn night into day:—Tallow. (*I* 66 [18] *r.*)

OF DOCTORS WHO LIVE UPON THE SICK

Men will come to such a state of misery that they will be grateful that others should profit by their sufferings, or by the loss of their true riches, that is health. (*I* 66 [18] *v.*)

[1] MS. 'talas.'

OF CANNON WHICH COME FORTH OUT OF A PIT AND FROM A MOULD

There shall come forth from beneath the ground that which by its terrific report shall stun all who are near it and cause men to drop dead at its breath, and it shall devastate cities and castles. (*C. A.* 129 *v. a.*)

OF CORN AND OTHER SEEDS

Men shall throw away out of their houses those victuals which were meant for the sustenance of their lives. (*B. M.* 263, *Ar.* 212 *b.*)

Many there will be who will wax great in destruction :—The ball of snow rolling over the snow.

There will be a great host, who, forgetful of their existence and their name, will lie as dead upon the spoils of other dead :—Sleeping upon the feathers of birds.

Oh! how many great buildings will be ruined by reason of fire :—By the fire of the guns.

(*B. M.* 263, *Ar.* 42 *b.*)

VI

OF PLOUGHED LAND

The earth will be seen turned upside down and facing the opposite hemispheres, and laying bare the holes where lurk the fiercest animals.

OF BRICKKILNS AND LIMEKILNS

At the last the earth will become red after being exposed to fire for many days, and the stones will become changed to ashes.

OF BOOKS WHICH INCULCATE PRECEPTS

Bodies without souls shall by their sayings supply precepts which shall help us to die well.

OF THE SHADOW THAT MOVES WITH MAN

There shall be seen shapes and figures of men and animals which shall pursue these men and animals wheresoever they flee; and the movements of the one shall be as those of the other, but it shall seem a thing to wonder at because of the different dimensions which they assume. (*C. A.* 370 *r. a.*)

OF THE SHADOW CAST BY MAN AT NIGHT WITH A LIGHT

There shall appear huge figures in human shape, and the nearer to you they approach the more will their immense size diminish. (*K* 50 [1] *v.*)

OF THE SHADOW CAST BY THE SUN AND OF THE REFLECTION IN THE WATER SEEN AT ONE AND THE SAME TIME

Many times one man shall be seen to change into three and all shall proceed together, and often the one that is most real abandons him.

OF THE WALLS OF CITIES REFLECTED IN THE WATER OF THEIR TRENCHES

The high walls of mighty cities shall be seen inverted in their trenches.

OF THE WATER WHICH FLOWS IN A TURBID STREAM MINGLED WITH EARTH, AND OF THE DUST AND MIST MINGLING WITH THE AIR AND OF THE FIRE WHICH MINGLES ITS HEAT WITH EACH

All the elements shall be seen confounded together, surging in huge rolling mass, now towards the centre of the earth, now towards the sky ; at one time coursing in fury from the southern regions towards the icy North, at another time from the East to the West, and so again from this hemisphere to the other.

OF THE NIGHT WHEN ONE CANNOT DISTINGUISH ANY COLOUR

It shall even come to pass that it will be impossible to tell the difference between colours, for all will become black in hue.

OF SWORDS AND SPEARS WHICH OF THEMSELVES NEVER DO HARM TO ANY ONE

That which of itself is gentle and void of all offence will become terrible and ferocious by reason of evil companionship, and will take the lives of many people with the utmost cruelty ; and it would slay many more if it were not that these are protected by bodies which are themselves without life, which have come forth out of pits,—that is by cuirasses of iron.

OF FIRE

From small beginnings shall arise that which shall rapidly become great ; and it shall have respect for no

created thing, but its power shall be such as to enable it to transform almost everything from its natural condition. (*C. A.* 370 *r. a.*)

OF WRITING LETTERS FROM ONE COUNTRY TO ANOTHER

Men from the most remote countries shall speak one to another and shall reply.

OF THE HEMISPHERES WHICH ARE INFINITE AND DIVIDED BY AN INFINITE NUMBER OF LINES IN SUCH A WAY THAT EVERY MAN HAS ALWAYS ONE OF THESE LINES BETWEEN HIS FEET

Men shall speak with and touch and embrace each other while standing each in different hemispheres, and shall understand each other's language.

(*C. A.* 370 *v. a.*)

The works of men's hands will become the cause of their death :—Swords and spears. (*I* 64 [16] *v.*)

OF STONES CHANGED INTO LIME WITH WHICH PRISON WALLS ARE BUILT

Many things which have previously been destroyed by fire will deprive many men of their liberty.

(*I* 66 [18] *v.*)

VII

You shall see plants continuing without leaves and rivers standing still in their courses.

The water of the sea shall rise above the high summits of the mountains towards the sky, and it shall fall down again on to the dwellings of men :—That is as clouds.

Men shall cast away their own food :—That is in sowing. (*I* 63 [15] *v.*)

The generation of men shall come to such a pass as not to understand one another's speech :—That is a German with a Turk.

Men shall come forth out of the graves changed to winged creatures, and they shall attack other men, taking away their food even from their hands and tables :—The flies.

Many there will be who will flay their own mother and fold back her skin :—The tillers of the ground. (*I* 64 [16] *r.*)

Many creatures of the earth and of the water will mount up among the stars :—The Planets.

You shall see the dead carrying the living in divers parts of the world :—The chariots and ships.

From many the food shall be taken away out of their mouths :—From ovens.

And those who have their mouths filled by the hands of others shall have the food taken away out of their mouths :—The oven. (*I* 66 [18] *r.*)

Snow in summer shall be gathered on the high mountain peaks and carried to warm places, and there be let to fall down when festivals are held in the piazza in the time of summer. (*Sul Volo degli Uccelli*, 14 [13] *r.*)

The east shall be seen to rush into the west and the south to the north, whirling themselves round about the universe with great noise and trembling :—The wind from the east which rushes into the west.

The rays of the sun will kindle fire on the earth whereby shall be set alight that which is beneath the sky, and reflected by whatever withstands their course they will turn downwards :—The concave mirror kindles the fire with which the oven is heated, and this has a foundation that stands beneath its roof.

A great part of the sea will fly towards the sky, and for a long time it will not return :—That is in clouds.

There remains the motion which separates the mover from the thing moved.

The dead shall come forth from under the earth, and by their fierce movements shall drive out of the world innumerable human creatures :—The iron which comes from under the earth is dead, and it makes the weapons wherewith so many men have been slain.

The greatest mountains even though they are remote from the sea borders will drive the sea from its place :—That is by the rivers which carry down the soil they have taken from the mountains and deposit it upon the seashores ; and where the earth comes the sea retires.

The water fallen from the clouds, which continue to move along the bases of the mountains, will stay for a long time without making any movement, and this will take place in many and divers regions :—Snow which falls in flakes,—which is water.

The great rocks of the mountains will dart forth fire,

such that they will burn up the timber of many vast forests and many beasts both wild and tame :—The flint of the tinder-box,—which makes a fire that consumes all the loads of faggots of which the forests are cleared, and with this the flesh of beasts is cooked.

(*B. M.* 263, *Ar.* 42 *b.*)

VIII

OF ADVICE

He who shall be most necessary to whoever has need of him will be unknown, and if known will be held of less account. (*C. A.* 37 *v. c.*)

All those things which in the winter are concealed and hidden beneath the snow will be left bare and exposed in summer :—Said of a lie which cannot remain hidden.

(*I* 39 *v.*)

OF THE FEAR OF POVERTY

The malevolent and terrifying thing shall of itself strike such terror into men that almost like madmen while thinking to escape from it they will rush in swift course upon its boundless forces. (*C. A.* 37 *v. c.*)

Happy will be those who give ear to the words of the dead :—The reading of good books and the observing of their precepts. (*I* 64 [16] *r.*)

Men will pursue the thing they most fear :—That is they will be miserable lest they should fall into misery.

Things severed shall be united and shall acquire of themselves such virtue that they shall restore to men

their lost memory :—That is, the papyrus sheets which are formed out of severed strips and preserve the memory of the thoughts and deeds of men.

(*I* 64 [16] *v.*)

OF THE SKINS OF ANIMALS WHICH HAVE THE SENSE OF FEELING OF WHAT IS WRITTEN THERE

The more you converse with skins covered over with sentiments, the more you will acquire wisdom.

OF THE MOUTH OF MAN WHICH IS A TOMB

There shall come forth loud noises out of the tombs of those who have died by an evil and violent death.

(*I* 65 [17] *v.*)

OF THE AVARICIOUS

Many there shall be who with the utmost zeal and solicitude will pursue furiously that which has always filled them with awe, not knowing its evil nature.

OF MEN WHO AS THEY GROW OLDER BECOME MORE MISERLY, WHEREAS HAVING BUT A SHORT TIME TO STAY THEY OUGHT TO BE MORE GENEROUS

You will see that those who are considered to be of most experience and judgment, in proportion as they come to have less need of things, seek and hoard them with more eagerness. (*C. A.* 370 *r. a.*)

OF MONEY AND GOLD

That shall come forth from hollow caves which shall cause all the nations of the world to toil and sweat with great agitation, anxiety and labour, in order to gain its aid. (*C. A.* 37 *v. c.*)

OF THE PRECIOUS METALS

There shall come forth out of dark and gloomy caves that which shall cause the whole human race to undergo great afflictions, perils, and death. To many of those who follow it, after much tribulation it will yield delight; but whosoever pays it no homage will die in want and misery. It shall bring to pass an endless number of crimes; it shall prompt and incite wretched men to assassinate, to steal, and to enslave; it shall hold its own followers in suspicion; it shall deprive free cities of their rank; it shall take away life itself from many; it shall make men torment each other with many kinds of subterfuge, deceits and treacheries.

O vile monster! How much better were it for men that thou shouldst go back to hell! For this the vast forests shall be stripped of their trees; for this an infinite number of creatures shall lose their lives.

(*C. A.* 370 *r. a.*)

OF THE DOWRIES OF MAIDENS

And whereas at first young maidens could not be protected from the lust and violence of men, either by the watchfulness of parents or by the strength of walls, there will come a time when it will be necessary for the fathers and relatives of these maidens to pay a great price to whoever is willing to marry them, even although they may be rich and noble and exceedingly beautiful. Herein it seems certain that nature desires to exterminate the human race, as a thing useless to the world and the destroyer of all created things.

OF THE CRUELTY OF MAN

Creatures shall be seen upon the earth who will always be fighting one with another with very great losses and frequent deaths on either side. These shall set no bounds to their malice; by their fierce limbs a great number of the trees in the immense forests of the world shall be laid level with the ground; and when they have crammed themselves with food it shall gratify their desire to deal out death, affliction, labours, terrors, and banishment to every living thing. And by reason of their boundless pride they shall wish to rise towards heaven, but the excessive weight of their limbs shall hold them down. There shall be nothing remaining on the earth or under the earth or in the waters that shall not be pursued and molested or destroyed, and that which is in one country taken away to another; and their own bodies shall be made the tomb and the means of transit of all the living bodies which they have slain. O Earth! what delays thee to open and hurl them headlong into the deep fissures of thy huge abysses and caverns, and no longer to display in the sight of heaven so savage and ruthless a monster?

(*C. A.* 370 *v. a.*)

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